

## UNCLASSIFIED

ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2 Exhibit)							DATE February 2000			
BUDGET ACTIVITY 1 - Basic Research				PE NUMBER AND TITLE 0601102A Defense Research Sciences						
COST (In Thousands)		FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
Total Program Element (PE) Cost		122255	125918	132164	130876	133026	135293	137416	Continuing	Continuing
AF20	Advanced Propulsion Research	2042	2422	2509	2607	2634	2656	2674	Continuing	Continuing
AF22	Research in Vehicular Mobility	450	472	485	493	501	508	515	Continuing	Continuing
AH42	Materials and Mechanics	1628	1915	1990	2040	2068	2087	2106	Continuing	Continuing
AH43	Research in Ballistics	3135	4008	4126	4226	4286	4340	4392	Continuing	Continuing
AH44	Advanced Sensors Research	4235	4041	4144	4231	4298	4362	4423	Continuing	Continuing
AH45	Air Mobility	1836	1978	2034	2089	2127	2163	2201	Continuing	Continuing
AH47	Applied Physics Research	2611	3073	3182	3271	3309	3340	3367	Continuing	Continuing
AH48	Battlespace Information & Communications Res	5436	6730	6927	7100	7205	7299	7390	Continuing	Continuing
AH52	Equipment for the Soldier	862	944	984	1015	1026	1032	1037	Continuing	Continuing
BH57	Scientific Problems with Military Applications	51999	50382	51559	52499	53413	54318	55232	Continuing	Continuing
AH66	Advanced Structures Research	1167	1409	1463	1508	1523	1534	1543	Continuing	Continuing
BH67	Environmental Research - Army Materiel Command	3092	3507	3570	3631	3696	3762	3828	Continuing	Continuing
AH68	Processes in Pollution Abatement Technology	349	368	374	380	387	395	402	Continuing	Continuing
BS04	Military Pollutants and Health Hazards	555	621	631	640	653	665	678	Continuing	Continuing
BS13	Science Base/Medical Research Infectious Disease	8784	8954	9185	9385	9567	9742	9916	Continuing	Continuing
BS14	Science Base/Combat Casualty Care Research	3517	3949	4042	4122	4196	4269	4340	Continuing	Continuing
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BS15	Science Base/Army Operational Medecine Research	9026	5353	5495	5617	5725	5827	5928	Continuing	Continuing
BS17	Molecular Biology/Military HIV Research	374	431	439	445	482	642	661	Continuing	Continuing
BS19	Telemedicne Soldier Status Research	450	611	620	631	609	672	703	Continuing	Continuing
BS20	Science Base Emerging Infectious Diseases	0	0	3975	0	0	0	0	3975	3975
AT22	Soil and Rock Mechanics	1654	1856	1887	1915	1952	1989	2028	Continuing	Continuing
AT23	Basic Research/Military Construction	1436	1549	1595	1619	1650	1682	1714	Continuing	Continuing
AT24	Snow, Ice and Frozen Soil	1244	2164	1185	1203	1217	1227	1237	Continuing	Continuing
BT25	Enviornmental Research - Corps of Engineers	3908	4425	4503	4569	4656	4746	4838	Continuing	Continuing
A305	Automatc Target Recognition	992	1169	1205	1235	1253	1268	1283	Continuing	Continuing
A31B	Infrared Optics Research	1985	2337	2426	2500	2531	2561	2589	Continuing	Continuing
B52C	Mapping and Remote Sensing	2098	2288	2327	2362	2408	2455	2503	Continuing	Continuing
B53A	Battlefield and Environment Signature	3134	3674	3812	3939	3983	4013	4039	Continuing	Continuing
B74A	Human Engineering	2219	2599	2687	2761	2795	2823	2850	Continuing	Continuing
B74F	Personnel Perormance and Training	2037	2689	2803	2843	2876	2916	2999	Continuing	Continuing
<p><b>A. <u>Mission Description and Justification:</u></b> This program element sustains U.S. Army scientific and technological superiority in land warfighting capability, provides new concepts and technological options for the maintenance of Army land power, and provides the means to avoid scientific surprise, while exploiting scientific breakthroughs. This program responds to the scientific and technological requirements of the Department of Defense Basic Research Plan, the Army Science and Technology Master Plan, and the Army Modernization Plan, and enables the technologies that could significantly improve joint warfighting capabilities. The in-house portion of the program capitalizes on the scientific talent and specialized facilities to expeditiously transition knowledge and technology into the appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry. This translates to a coherent,</p>										
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<p>well-integrated program which is executed by the following five primary contributors: 1) the Army Research Laboratory (ARL), which includes the Army Research Office; 2) the Army Materiel Command</p> <p>Research, Development and Engineering Centers (RDECs); 3) the Army Corps of Engineers laboratories; 4) the Army Medical Research and Materiel Command laboratories; and 5) the Army Research Institute. The Army's research program promotes quality through activities such as in-depth reviews of the entire basic research program at all levels and the establishment of strategic research objectives. The Army broadened its research base by expanding basic research investment in Historically Black Colleges and Universities and Minority Institutions (HBCU/MIs) to 5% of its individual investigator program. The basic research program is coordinated with the other Services via the Joint Directors of Laboratories panels, Project Reliance, and other interservice working groups.</p>																																															
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><b>B. Program Change Summary</b></th> <th style="text-align: center;"><u>FY 1999</u></th> <th style="text-align: center;"><u>FY 2000</u></th> <th style="text-align: center;"><u>FY 2001</u></th> </tr> </thead> <tbody> <tr> <td>Previous President's Budget (<u>FY 2000/2001</u> PB)</td> <td style="text-align: center;">125314</td> <td style="text-align: center;">125613</td> <td style="text-align: center;">128578</td> </tr> <tr> <td>Appropriated Value</td> <td style="text-align: center;">126463</td> <td style="text-align: center;">126613</td> <td></td> </tr> <tr> <td>Adjustments to Appropriated Value</td> <td></td> <td></td> <td></td> </tr> <tr> <td>a. Congressional General Reductions</td> <td style="text-align: center;">-1149</td> <td></td> <td></td> </tr> <tr> <td>b. SBIR / STTR</td> <td style="text-align: center;">-3079</td> <td></td> <td></td> </tr> <tr> <td>c. Omnibus or Other Above Threshold Reductions</td> <td></td> <td style="text-align: center;">-370</td> <td></td> </tr> <tr> <td>d. Below Threshold Reprogramming</td> <td style="text-align: center;">630</td> <td></td> <td></td> </tr> <tr> <td>e. Rescissions</td> <td style="text-align: center;">-610</td> <td style="text-align: center;">-325</td> <td></td> </tr> <tr> <td>Adjustments to Budget Years Since (<u>FY 2000/2001</u> PB)</td> <td></td> <td></td> <td style="text-align: center;">+3586</td> </tr> <tr> <td>Current Budget Submit (<u>FY 2001</u>PB)</td> <td style="text-align: center;">122255</td> <td style="text-align: center;">125918</td> <td style="text-align: center;">132164</td> </tr> </tbody> </table>				<b>B. Program Change Summary</b>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	Previous President's Budget ( <u>FY 2000/2001</u> PB)	125314	125613	128578	Appropriated Value	126463	126613		Adjustments to Appropriated Value				a. Congressional General Reductions	-1149			b. SBIR / STTR	-3079			c. Omnibus or Other Above Threshold Reductions		-370		d. Below Threshold Reprogramming	630			e. Rescissions	-610	-325		Adjustments to Budget Years Since ( <u>FY 2000/2001</u> PB)			+3586	Current Budget Submit ( <u>FY 2001</u> PB)	122255	125918	132164
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AF20</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AF20 Advanced Propulsion Research	2042	2422	2509	2607	2634	2656	2674	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project is a joint Army/NASA effort and it is the only DoD basic research project focused on turboshaft engine-specific technology and mechanical power transmission technology. The Army is the lead service in these technology areas (under Project Reliance) and performs basic research in propulsion, as applicable to rotorcraft and tracked and wheeled vehicles. Analysis, code generation, experiments and evaluations are conducted to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls. The goal of the activity is increased performance of small air-breathing engines and power trains that will support improvements in system mobility, reliability and survivability, and ultimately serve to reduce the logistics cost burden on future concepts, including the Future Combat Systems (FCS) program. Logistic issues are key concerns in the Army After 2010 planning.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2042 - Achieved quick execution (overnight turn around) for Version 2.0 of the National Combustor Code, providing an increased incentive for industry to use the code. Successfully completed Level 1 PCA Milestone (Program Commitment Agreement to Congress) entitled "Reduce Turnaround Time on Aerospace Application by 200-to-1 Relative to a 1992 Baseline". The National Combustor Code performed a 1.3 million node calculation of the flow from the exit of a compressor through the combustor to the entrance of the turbine of a gas turbine engine with a 10-hour turnaround time.</li> <li>- Completed 3-D gear crack propagation code to improve transmission safety.</li> <li>- Investigated improved high temperature mechanical property stability of SiC/SiC composites through microstructural control.</li> <li>- Obtained images in a centrifugal compressor diffuser of velocity transients between steady flow and surge that contain diffuser stall cell, pre-stall and post-stall structures.</li> <li>- Completed investigation of stator end wall blockage effects on performance of multistage axial compressor. These results will ultimately enable significant improvements in compressor efficiency to be realized through reductions in secondary flow losses.</li> <li>- Calibrated 3-D gear crack propagation code with data from Boeing single tooth bending fatigue test gear in order to improve transmission design safety.</li> <li>- Investigated material and lead wire attachment technique for ceramic based thin film strain gauges for use to 1200°C.</li> <li>- Attained first 4-port through-flow wave rotor map experimentally.</li> <li>- Completed aerodynamic design of an efficient wave rotor-to-high pressure turbine transition duct.</li> </ul> <p>Total            2042</p>									
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<p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>2410</div> <div> - Investigate a surge model for centrifugal compressors. Use model to determine mass flow injection schedules for centrifugal compressor range improvement experiments. Validate model through rig tests.  - Complete measurement of unsteady correlations and rotor tip clearance in a multistage axial compressor. These results will ultimately enable improvements in compressor performance to be realized by improvements in the predictive capability of 3-D viscous computational analysis tools for multistage axial compressors  - Apply particle image velocimetry to centrifugal compressor research stage at peak operating point to capture detailed flow physics associated with the onset of stall/surge. This data will enable the realization of flow physics based active stabilization and hence improved component efficiency.  - Characterize the coupling between internal convection and external film cooling for turbine blades. The resulting models will provide insight into the internal cooling and film cooling heat transfer process, and ultimately improve efficiency by reducing the need for parasitic cooling flow.  - Complete investigation of comprehensive thermomechanical life prediction model for advanced structural ceramics enabling insertion of durable structural ceramics into manned gas turbines.  - Acquire data for validation of analysis for spiral bevel gear thermal behavior, leading to reduced rotorcraft drive train weight and increased safety.  - Assist industry with extension of gear tooth crack propagation code to shaft coupling tooth crack propagation (National Rotorcraft Technology Center program).  - Complete mechanical design and structural analysis of a wave rotor "rotor".  - Apply micro-elastohydrodynamic lubrication analysis for lubrication of superfinished gears to complete gear contact stress analysis.  - Develop communication protocols and signal processing techniques for use with ultrasound wireless data transmission system. </div> </div> </li> <li> <div> <div>12</div> <div>Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</div> </div> </li> </ul> <p>Total 2422</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>2509</div> <div> - Incorporate environmental effects in life prediction model for advanced structural ceramics, including effects due to combustion products.  - Investigate wave rotor concept for on-rotor combustion, thereby integrating high-pressure turbomachinery and combustor component functions into a single component. This cycle is projected to reduce fuel consumption by 16% and increase specific power by 18%.  - Apply and assess the validity of newly developed engine weight and safety prediction algorithms. These algorithms will forecast the impact of new advanced technology on the weight and safety of new engines.  - Validate gear fault detection methodology incorporating sensor fusion for improved rotorcraft transmission safety and reliability.  - Integrate first version of gear crack imitation code with crack propagation code in rotorcraft drive system safety model. </div> </div> </li> </ul> <p>Total 2509</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AF22</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AF22 Research in Vehicular Mobility	450	472	485	493	501	508	515	Continuing	Continuing

  

**Mission Description and Justification:** This project conducts research in support of advanced military vehicle technology with emphasis on advanced propulsion, sophisticated vehicle dynamics and simulation, and advanced track and suspension concepts. Advanced propulsion research will dramatically improve power density, performance and thermal efficiency for advanced adiabatic diesel engines, transient heat transfer, high temperature materials and thermodynamics. This project also supports state-of-the-art simulation technologies to achieve a more fundamental understanding of advanced high-output military engines. The subject research is directed at unique, state-of-the-art phenomena in specific areas such as: 1) non-linear ground vehicle control algorithms, using off-road terrain characteristics; and 2) instantaneous diesel engine optimizations, using advanced analytical and experimental procedures. The subject efforts offer an opportunity to produce quantum performance enhancements for Army ground vehicles through the use of optimized parameterization procedures. Specific tasks within this Project directly support the Future Combat System.

**FY 1999 Accomplishments:**

- 450 - Validated state-of-the-art vehicle dynamics phenomena.
- - Optimized vehicle/human control models for off-road scenarios.
- - Optimized fundamental power train characteristic phenomena using advanced simulation procedures.

Total 450

**FY 2000 Planned Program:**

- 245 - Validate advanced power train simulation algorithms.
- - Derive militarily relevant system powertrain sensitivities.
- 219 - Enhance state-of-the-art, real-time vehicle dynamics understanding.
- 8 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.

Total 472

**FY 2001 Planned Program:**

- 240 - Fundamentally improve unique propulsion combustion/fuel injection modeling capability.
- 245 - Use high fidelity non-linear validation techniques to examine military vehicle response.

Total 485

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<i>COST (In Thousands)</i>	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH42 Materials and Mechanics	1628	1915	1990	2040	2068	2087	2106	Continuing	Continuing

**Mission Description and Justification:** This project funds the Army's basic research program in materials science. The goal is to establish the science base allowing the creation and production of advanced materials which will provide higher performance, lower cost, improved reliability, and environmental compatibility for Army unique applications. Emphasis is on understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, advanced metals, and multifunctional materials. These advanced materials will enable lethality and survivability technologies for the Future Combat Systems (FCS). This research is conducted by the Army Research Laboratory, at the Aberdeen Proving Ground, MD and at the NASA Langley Research Center in Hampton, VA in support of materials technology applied research in project 0602105A/AH84.

**FY 1999 Accomplishments:**

- 1628 - Revised first generation low-cycled fatigue model to account for fiber architecture, fiber-matrix microstructure, and interphase relationships to more accurately predict the performance of polymer matrix composites
- Coupled micro- and macro-models for improved prediction of micro-cracking and durability in thick section composites used for lightweight vehicles and ordnance.
- Determined critical parameters effecting the formation of AION ceramic microstructure and its relationship to the physical properties of transparent armor.
- Provided first generation model to enable engineering surface sensitive properties of materials using energetic directed ion-laser beam techniques
- Devised experimental technique to determine the dynamic behavior and defeat mechanisms of conceptual armor materials subjected to multiple external excitations.
- Established cooperative activity with Brunel Univ. to improve adaptive integration methods for modeling elastomeric materials and highly damped structures, and transfer in-house nonlinear viscoelastic models of elastomers to Penn. State Univ. and Lord Corp., Erie, PA.
- Completed four-point-bending static tests on thick curved composites to validate failure criteria.

Total 1628

**FY 2000 Planned Program:**

- 1904 - Determine the synthesis-microstructure-property relationships in polymer/clay nanocomposite materials.
- Refine low cycle fatigue predictive models for integrally-designed armor composite materials that include effects of material flaws and damage
- Investigate processing-microstructure effects on elastic properties of a functionally graded material.
- Extend predictive models and experimental techniques for cluster beam and pulsed laser ablation deposition of protective coatings.

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<p>- Investigate and devise coupled theoretical models for constitutive laws governing the high strain rate behavior of lightweight metal alloys and hybrid armor candidate materials.</p> <p><b>FY 2000 Planned Program: (continued)</b></p> <p>- Extend numerical and design models of elastomeric structures to include higher order plate and shell finite elements, and evaluate large strain combined loads viscous models against measured data.</p> <ul style="list-style-type: none"> <li>• 11 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 1915</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1990 - Investigate the effects of interfacial chemistry on the engineering properties and microstructural damage/failure mechanisms of organic/inorganic nanocomposites.</li> <li>- Explore novel technologies for damage detection and mitigation in lightweight, multifunctional armor materials.</li> <li>- Investigate alternative uses of cluster beam techniques to enhance surface quality and durability in vacuum processes.</li> <li>- Investigate shock response and micromechanical damage/failure mechanism of a functionally graded material.</li> <li>- Investigate failure mechanisms in metal/ceramic hybrid materials under complex stress states and conduct two-dimensional shock experiments on novel, lightweight armor materials.</li> <li>- Evaluate the possible extension and application of this computational, elastomeric material modeling technology area to intelligent material systems, including electro-rheological fluids.</li> </ul> <p>Total 1990</p>		
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<i>COST (In Thousands)</i>	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH43 Research in Ballistics	3135	4008	4126	4226	4286	4340	4392	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project funds the Army's basic research program in ballistics. The goal is to improve the understanding of the chemistry and physics controlling the propulsion and flight of gun launched projectiles and the flight of missiles, and to understand the interaction of these weapons with armored targets. This research results in the science base which allows the formulation of more energetic propellants, more accurate and lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems, including the Future Combat Systems (FCS). This research is conducted at the Army Research Laboratory, Aberdeen Proving Ground, MD in support of ballistic technology applied research in project 0602618A/AH80.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 3135 - Devised molecular modeling capability to predict heats of formation of novel propellant formulations; furthered execution of three dimensional computational fluid dynamic model for predicting ignition of multi-phase, multi-dimensional charge configurations – applied model to Modular Artillery Charge for Crusader</li> <li>- Provided capability that couples computational fluid dynamics and rigid body computational techniques to compute the flight aerodynamics of complex missiles and smart munitions; aerodynamic forces for various designs of an extended range projectile were computed for multiple angles of attack at a transonic velocity.</li> <li>- Devised constitutive model and experimental techniques to determine the coupled effect of mechanical, electrical and magnetic fields on armor and projectile materials for ballistic applications.</li> </ul> <p>Total            3135</p>									
<div style="display: flex; justify-content: space-between;"> <span>Project AH43</span> <span>Page 9 of 57 Pages</span> <span>Exhibit R-2A (PE 0601102A)</span> </div>									

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<p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>3952</div> <div> - Investigate theoretical chemistry and physics-based models, including 3-dimensional (3-D) ballistics models of future high performance solid propellants, validated by ignition and combustion experimentation, to predict mechanical stability, impetus, energy release, flame temperature, and critical intra- and inter-molecular propellant properties.  - Couple computational fluid dynamics/thermal/rigid body dynamics tools for complex aerodynamic shapes and launch dynamics of advanced munitions.  - Incorporate coupled constitutive models into the magneto-solid-mechanics version of the CTH model (a computational solid mechanics model developed by Sandia National Laboratory) being developed as part of the work package on electrodynamic defeat of anti-armor threats.  - Perform shock wave propagation experiments in functionally graded materials to determine the effect of directionality on its shock, release, tensile and energy dissipation properties. Determine the effect of the material property gradient on wave front curvature and amplitude for general directions of propagation. </div> </div> </li> <li> <div> <div>56</div> <div>- Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</div> </div> </li> </ul> <p>Total 4008</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>4126</div> <div> - Refine predictive first principles of chemistry and physics-based models and 3-D interior ballistics models and apply ignition and combustion experimental data to predict ballistic properties of advanced high-performance solid propellants in propulsion systems.  - Devise advanced computational models, smart munitions aerodynamic prediction capabilities, and flight vehicle control element design tools to reduce design cycle time and cost of advanced munitions.  - Incorporate fundamental theory of shock propagation in Functionally Graded Materials (FGMs) into wave mechanics code and complete critical experiments to validate the model. Complete integration of FGM constitutive model to provide 3-D modeling capability for the design of FGMs that will enable future lightweight combat vehicle concepts. </div> </div> </li> </ul> <p>Total 4126</p>		
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<b>COST (In Thousands)</b>	<b>FY1999 Actual</b>	<b>FY 2000 Estimate</b>	<b>FY 2001 Estimate</b>	<b>FY 2002 Estimate</b>	<b>FY 2003 Estimate</b>	<b>FY2004 Estimate</b>	<b>FY2005 Estimate</b>	<b>Cost to Complete</b>	<b>Total Cost</b>
AH44 Advanced Sensors Research	4235	4041	4144	4231	4298	4362	4423	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project exploits new opportunities in the basic sciences underpinning the technology areas of digital and image processing modules and algorithms, information capacity of electro-optical imaging systems, nonlinear optical materials and devices, remote sensing, emissive materials and intelligent system distributive interactive simulations and battlefield acoustic signal processing algorithms. Research involves fundamental science and engineering principles that support survivable sensor systems, displays, and environmental monitoring, both point and remote. Monolithic and hybrid optoelectronic structures in gallium arsenide and lithium niobate are investigated as integrated processors for novel signal and radar processing and control. Diffractive and micro-optic elements are investigated to enhance performance of imagers and optical processors. For laser protection, nonlinear optical effects are being explored which will allow broad band protection. These nonlinear effects can also be used for optical image processing or holographic displays and storage.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 654 - Established numerical tool set for quantifying the information capacity of an electrooptic (EO) imaging system.             <ul style="list-style-type: none"> <li>- Determined feasibility of optical limiter for TARDEC application.</li> <li>- Investigated the luminescence properties of nanocrystalline phosphors and organic materials for emissive displays.</li> <li>- Characterized and Fabricated binary, subwavelength diffractive lens.</li> </ul> </li> <li>• 2117 - Determined a real-time technique for extracting depth information from an image stream, applying nonlinear optical techniques.             <ul style="list-style-type: none"> <li>- Conducted image processing using the mathematics of partial differential equations implemented as a real-time parallel analog optoelectronic processor.</li> <li>- Established a correlation between trajectory likelihood and the magnitude of its associated exponent and established a technique to evaluate closure models and their trajectories using Lyapunov exponents.</li> </ul> </li> <li>• 1378 - Used electromagnetic model results of an anti-tank mine to generate synthetic aperture radar images in three-dimensions. Used the 3D images to evaluate achievable resolution in a forward imaging configuration.             <ul style="list-style-type: none"> <li>- Calculated the cross-range superresolution with a scanning radar for targets at various ranges using multiple signal classification (MUSIC).</li> </ul> </li> <li>• 86 - Investigated several innovative acoustic signal processing techniques.</li> </ul> <p>Total 4235</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1494 - Determine the optimal luminescence material for low power high brightness display.             <ul style="list-style-type: none"> <li>- Investigate designs for low cost, low power imaging system for Warrior Extended Battlespace Sensor System (WEBS).</li> <li>- Integrate binary, subwavelength lens with vertical cavity surface emitting laser.</li> </ul> </li> </ul>									
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>AH44</b>
<p><b>FY 2000 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li> <div> <div>•</div> <div> <div>797</div> <div> - Record and fix gratings in photorefractive media for 3D holograms.  - Further design and test iterative algorithms for designing subwavelength diffractive optical elements.  - Report on analysis of dielectric mine measurements for increased mobility of Future Combat Systems (FCS).  - Investigate cross-range superresolution of complex targets with scan-MUSIC (S-MUSIC) for improved automatic target recognition (ATR) thereby providing increased lethality of FCS. </div> </div> </div> </li> <li> <div> <div>•</div> <div> <div>1678</div> <div> - Utilize fuzzy logic to control level of object detail and to model volumetric objects while maintaining a constant frame rate.  - Investigate and report on techniques for the real-time rectification of sensor imagery utilizing nonlinear and adaptive optics.  - Utilize Lyapunov exponents based closure model to assess the improvement of turbulence calculations as related to acoustic and optical sensors. </div> </div> </div> </li> <li> <div> <div>•</div> <div> <div>72</div> <div> - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs. </div> </div> </div> </li> </ul> <p>Total 4041</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>•</div> <div> <div>2486</div> <div> - Record and fix multiplexed gratings in a 3D hologram.  - Design low power high brightness display for Army applications.  - Design nonlinear optical materials for eye protection using current optical viewing designs.  - Complete analysis and documentation of ultra-wideband (UWB) ground penetrating radar utility analysis for mine/unexploded ordnance (UXO) detection for increased mobility of FCS.  - Extend capabilities of S-MUSIC and blind deconvolution superresolution algorithms and validate applicability using field data for improved ATR thereby providing increased lethality of FCS. </div> </div> </div> </li> <li> <div> <div>•</div> <div> <div>1658</div> <div> - Establish techniques for real-time rectification of sensor imagery utilizing features with the scene.  - Investigate the effects of turbulence induced phase and intensity fluctuations on ground to ground laser systems and identify techniques to reduce the effects. </div> </div> </div> </li> </ul> <p>Total 4144</p>		
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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>AH45</b>	
<i>COST (In Thousands)</i>	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH45 Air Mobility	1836	1978	2034	2089	2127	2163	2201	Continuing	Continuing

**Mission Description and Justification:** Basic research in aerodynamics and avionics as applied to rotary wing aircraft. Analysis, code development, and test and evaluation are conducted on rotor unique aerodynamics, dynamics, performance, and aircraft performance and acoustics.

**FY 1999 Accomplishments:**

- 1836 - Identified structure/actuator concepts for application to multi-controller active, on-blade systems for low vibration rotorcraft.
- Fabricated an isolated, instrumented baseline rotor for increased payload, reduced noise and vibration.
- Investigated stereo particle image velocimetry for rotor wake measurements.
- Completed research on advanced aeroacoustic prediction code using parallel computer.
- Completed research on pressure sensitive paint technique for blade surface pressure measurement
- Performed forward flight aeroelastic stability testing of swept tip hingeless rotor blades.
- Investigated aeroelastic and dynamic response of on-blade elevon controls for vibration reduction.

Total 1836

**FY 2000 Planned Program:**

- 1931 - Complete research of stereo image velocimetry technique.
- Complete detailed rotor wake geometry measurements during blade/vortex interaction using stereo image velocimetry technique.
- Complete an axial-flight wind tunnel test to separate induced power from total power measurement.
- Design and fabricate scale model rotor blades equipped with oscillating blowing to control flow separation.
- Perform analytic validation of swept tip blade stability characteristics.
- Conduct parametric studies of active control with on-blade elevons for low vibration rotors.
- 47 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.

Total 1978

**FY 2001 Planned Program:**

- 2034 - Complete rotor aerodynamic and acoustic codes using scalable software.
- Complete hover test using model blades equipped with oscillating blowing to control flow separation.
- Investigate aeroelastic coupling characteristics for improved rotor stability.
- Validate analytical methods for on-blade control vibration characteristics.

Total 2034

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>AH47</b>	
<i>COST (In Thousands)</i>	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH47 Applied Physics Research	2611	3073	3182	3271	3309	3340	3367	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> The objective of this project is to investigate the physics of various phenomena occurring in semiconductor structures, including thin heterostructure systems where quantum confinement effects are important. Also investigate relativistic effects on accuracy of global positioning system (GPS). The basic knowledge learned will be applied to novel optoelectronic devices. Active and passive optoelectronic components and subsystems that are of importance for Army systems will be investigated. These include applications for superlattice-based lasers and detectors, and optical signal processing. From a logistical point of view it is important that the Army capitalize on advancements in semiconductor optoelectronics because of the potential for vastly reduced system size, weight, and cost as well as for the drastic improvements in system performance that optoelectronics can provide. Reduced size, weight and cost and higher operating temperature are especially important for future combat vehicles, including the Future Combat Systems (FCS).</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2137 - Established performance of type II quantum cascade lasers from GaSb based materials operating at 3.5μm and 240°K.</li> <li style="padding-left: 20px;">- Established fully general relativistic equations/algorithm for GPS positioning and time transfer.</li> <li style="padding-left: 20px;">- Established strain-effect-enhanced wave-guide modulators and amplifiers.</li> <li>• 474 - Synthesized new anode material for higher energy rechargeable batteries for reduced weight and cost.</li> <li style="padding-left: 20px;">- Synthesized new electrolyte solvents for capacitors and rechargeable lithium-ion batteries.</li> <li style="padding-left: 20px;">- Synthesized/evaluated new cathodic electrocatalysts for high performance methanol fuel cells for individual soldier applications.</li> <li>Total 2611</li> </ul> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2455 - Establish cylindrical model of Q-switch for micro-laser.</li> <li style="padding-left: 20px;">- Advance InAs/GaSb based superlattice detector and laser structures.</li> <li style="padding-left: 20px;">- Investigate equations for navigation in a curved space-time.</li> <li style="padding-left: 20px;">- Explore semiconductor strain effects and wide bandgap physics for future optoelectronic components.</li> <li>• 594 - Investigate/eliminate side-reactions limiting storage and low temperature performance of new, more energetic anode material for rechargeable lithium-ion batteries.</li> <li style="padding-left: 20px;">- Synthesize new solvent for capacitor electrolyte to enable low temperature operation in burst communications applications.</li> <li style="padding-left: 20px;">- Evaluate conductivity and chemical stability of new membrane electrolytes for high performance fuel cells.</li> <li>• 24 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> <li>Total 3073</li> </ul>									
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>AH47</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2540 - Investigate materials with low defects for electrically pumped interband quantum cascade laser with optimized operating characteristics and investigate InAs/GaSb based superlattice detector. <ul style="list-style-type: none"> <li>- Establish positioning algorithm in the Fermi frame of reference of the earth.</li> <li>- Investigate wide bandgap active device structures.</li> </ul> </li> <li>• 642 - Formulate solid electrolyte for rechargeable lithium battery with high energy density/good low temperature performance. <ul style="list-style-type: none"> <li>- Formulate new high voltage low temperature electrolyte for high performance electrochemical capacitor.</li> <li>- Improve Lithium/polymer battery chemistry for long storage, high energy density battery.</li> <li>- Improve chemistry for direct methanol fuel cell.</li> </ul> </li> </ul> <p>Total 3182</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AH48</b>	
COST (In Thousands)	FY1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY2004 Estimate	FY2005 Estimate	Cost to Complete	Total Cost
AH48 Battlespace Information & Communications Res	5436	6730	6927	7100	7205	7299	7390	Continuing	Continuing

**Mission Description and Justification:** This project addresses fundamental research in technologies that will enable intelligent and survivable command, control, communication, and intelligence systems. As the combat force structure becomes smaller and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. This research will address the areas of information assurance and the related signal processing for wireless battlefield communications along with intelligent systems for C4I. The information assurance and signal processing research will provide capabilities that will enable the Army to overcome the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, diverse networks with dynamic topologies, high level multi-path interference and fading, jamming and multi-access interference, and information warfare threats. The intelligent systems for C4I research will focus on providing the agent technology capabilities that will reduce the cognitive load on the commander, improve the timeliness, quality and effectiveness of actions and in the long run speed the decision-making process and reduce the size of tactical operation center (TOC) staffs.

**FY 1999 Accomplishments:**

- 3540 - Provided secure mobility management techniques for mobile host protocols that support mobile ad-hoc network configurations.
  - Investigated several survivable information architectures for information protection that addresses security, software reliability, data integrity, and system recoverability and produced a preliminary report.
  - Define mobile distributed multiple access Anti-Jam (AJ) communication networks for brigade and below.
  - Conducted a set of simulations of software intelligent agents that can detect information operations on combat networks.
  - Conducted research on hierarchical digital modulation algorithms for classification and identification of signals on the battlefield and published technical papers of findings.
  - Examined the use of robust spatial diversity combining algorithms for tactical communications.
  - Provided algorithms for performing channel and source coding for tactical communications, with error correcting codes, that are capable of operating in high-bit error battlefield environments.
- 1896 - Provided user alert agent technology utilizing University of Maryland's intelligent agent architecture.
  - Investigated the interaction of humans and intelligent agents with a focus on agent autonomy.
  - Defined requirements and approach for an agent that monitors event detection and synchronization over bandwidth limited channels.
  - Examined the theoretical foundation of cooperative intelligent agents that will underpin the Army Command Support System.
  - Investigated the application of soft computing techniques (fuzzy logic, neural nets, etc.) to enable agents to deal with uncertainty.

Total 5436

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>AH48</b>
<p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 4130 - Refine secure mobility management techniques for mobile host protocol that support mobile ad-hoc networking on the move. <ul style="list-style-type: none"> <li>- Refine intelligent agents for vulnerability assessment of dynamic tactical networks.</li> <li>- Evaluate concept for mobile distributed multiple access Anti-Jam (AJ) communication networks for brigade and below.</li> <li>- Complete investigation of survivable information architectures for information protection that address security, software reliability, data integrity and system recoverability.</li> <li>- Evaluate and refine hierarchical digital modulation algorithms for classification and identification of signals on battlefield.</li> <li>- Develop spatial diversity combining algorithms for tactical communications</li> <li>- Evaluate and refine algorithms for performing channel and source coding for tactical communications that are capable of operating in high-bit error battlefield environments.</li> </ul> </li> <li>• 2489 - Validate intelligent agent architecture by testing architecture and alert agent technology in collaboration with the Advanced Battlefield Processing Technology Science and Technology Objective (STO). <ul style="list-style-type: none"> <li>- Document the critical aspects of human-agent interaction that must be considered in the development of agent applications.</li> <li>- Assess the extensibility and adaptability of the intelligent agent architecture to the synchronization of physical and software agents against a user defined mission plan.</li> <li>- Conduct detailed research on the language that will facilitate agent-to-agent communication to expand the theoretical foundations of cooperative intelligent agents.</li> <li>- Evaluate the use of soft computing approaches to enhance the ability of agents to deal with uncertainty.</li> <li>- Assess the application of intelligent agent technology to natural language understanding and context tracking.</li> </ul> </li> <li>• 111 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 6730</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 4072 - Provide efficient algorithms for Internet protocols for highly mobile tactical networks for experimental applications. <ul style="list-style-type: none"> <li>- Review final hierarchical digital modulation algorithms by testing, identifying and classifying complex signals.</li> <li>- Utilize a mobile ad-hoc network to interconnect a team of physical agents and higher echelons to show improved information flow.</li> <li>- Validate the performance of source and channel coding for tactical communications in high bit error battlefield environments.</li> <li>- Validate hierarchical digital modulation algorithms for classification and identification of signals on battlefield.</li> <li>- Validate performance of spatial diversity combining algorithms for tactical communications.</li> </ul> </li> <li>• 2855 - Validate intelligent agents for mission planning, rehearsal and status monitoring of a physical agent.</li> </ul>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>AH48</b>
<p>- In collaboration with the Advanced Battlefield Processing Technology STO, display the state of physical or software agents through a 2D/3D battlespace situation display.</p> <p><b>FY 2001 Planned Program: (continued)</b></p> <p>- Evaluate the robustness of the theoretical foundation for cooperating agents by using its architecture and control language to integrate agents assessing the network vulnerability in conjunction with agents that monitor the execution of the mission.</p> <p>- Validate the performance of natural language and context tracking agents that understand speaker's intent while visualizing graphical information.</p> <p>Total            6927</p>		
<p>Project AH48</p> <p align="center"><i>Page 18 of 57 Pages</i></p> <p align="right">Exhibit R-2A (PE 0601102A)</p>		

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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>AH52</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AH52 Equipment for the Soldier	862	944	984	1015	1026	1032	1037	Continuing	Continuing

**Mission Description and Justification:** Basic research focused on five core technology areas critical to the Soldier System: mathematical modeling, physical performance measurement, polymer science/textile technology, biotechnology and food technology. Research is targeted toward enhancing the mission performance, survivability, and sustainability of the soldier by advancing the state of the art in defense against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and shortfalls in the availability of nutritious, performance sustaining rations essential to the health and well-being of soldiers.

**FY 1999 Accomplishments:**

- 862 - Screened new materials using "electrospinning" technology for the production of "seamless" multifunctional protective clothing.
- Validated mathematical models of textile damage effects from abrasion, strain, and ballistic impacts.
- Incorporated production variables into the assessment of physical and chemical factors affecting nonlinear optical behavior of candidate laser eye protective material.
- Applied sophisticated analytical methodologies to formulated meat proteins to determine the effects of microwave sterilization of military rations.
- Quantified soldier physical performance emphasizing biomechanical and anthropometric parameters of the soldier's load.
- Characterized the form and function of polymer/clay nanocomposites relevant to high performance, multifunctional fabrics and structures for the protection of the future soldier.
- Conducted computational experiments to provide validated model algorithms that predict the performance of airdrop systems necessary for projecting the force using DoD High Performance Computing resources.

Total 862

**FY 2000 Planned Program:**

- 942 - Elucidate photochemical deterioration inherent in nonlinear optical materials used in eye protection.
- Provide quantification of comfort measures for combat clothing to allow rapid improvements in design without impact on function.
- Investigate models for high strain rates in polymeric fabric systems to correlate with prediction of ballistic performance.
- Evaluate bioceramic approach to tailor templates for the evolution of high performance nanoceramics for lightweight ballistic protection.
- 2 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.

Total 944

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>AH52</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"><li>• 984 - Prepare nanoparticles of nonspherical and nonlinear geometries to begin evaluation of their potential in improving the strength of composites for use in lightweight systems.</li><li>- Validate the applicability of molecular modeling codes to predict the one-dimensional strain in candidate high strength polymeric systems for use in soldier protective items.</li><li>- Relate the uniform comfort measures to soldier performance using a multidomain indicator of performance.</li></ul> <p>Total 984</p>		
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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BH57</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BH57 Scientific Problems with Military Applications	51999	50382	51559	52499	53413	54318	55232	Continuing	Continuing

**Mission Description and Justification:** This extramural research project seeks to capture and exploit new scientific opportunities and technology breakthroughs, primarily at universities, to improve the Army's future operational capabilities. The Army Research Office maintains a strong peer-reviewed scientific research program through which technological improvements to warfighting capability can be assessed and implemented. Included are research efforts of scientific study and experimentation directed toward increasing knowledge and understanding in fields related to long-term national security needs and covering the physical sciences (physics, chemistry, biology, and materials sciences), the engineering sciences (mechanics, aeronautics, electronics, and mathematical and computer sciences), and the environmental sciences (atmospheric and terrestrial). It covers approximately 575 research grants and contracts with leading academic researchers and approximately 1,400 graduate students yearly, and supports research at over 100 institutions in 44 states.

**FY 1999 Accomplishments:**

- 23292 - Improved survivability of armor by creating high performance ceramic/metal reinforced bulk metallic glass composites with a 1000% increase in compressive strain to failure and with a 50% increase in absorbed energy.  
 - Utilized electromagnetically induced transparency in laser cooled and trapped atoms to slow the movement of light which has applications to optical computing/processing and nonlinear optical effects with extremely low intensity light.  
 - Demonstrated that nanoparticles of metal oxides adsorb and destroy hazardous compounds.  
 - Identified two genes that affect hibernation and may lead to the soldier's ability to resist hypothermia.
- 24007 - Produced the highest bandwidth per channel to date for an optoelectronic integrated circuit photoreceiver array, enabling potential applications in ultrafast information processing.  
 - Developed an important new tool, the 3-D front tracking method, which may overcome the semiconductor manufacturing problem involving deposition and etching.  
 - Incorporated an embedded network of piezoelectric ceramics into dielectric films to create efficient, low cost composite manufacturing techniques for "smart" structures such as rotor blades.  
 - Developed a new theory of sound propagation that accounts for temperature fluctuations and isotropic turbulence for acoustic tracking of tanks and helicopters.
- 4700 - Enhanced science, mathematics and engineering education programs at Historically Black Colleges/Minority Institutions to improve their capacity to conduct science and engineering research in areas critical to the Army through the acquisition of state-of-the-art research equipment and instrumentation.

Total      51999

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BH57</b>
<p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 22282 - Develop new biomimetics synthetic processing routes to produce laminated ceramic-polymer composites for improved armor.</li> <li>- Synthesize reactive “smart” polymers that can react to external stimuli for thermal and visible signature reduction of soldiers and equipment.</li> <li>- Apply quantum effects such as entanglement and nonlocality to develop enhanced techniques for information storage, communication, and processing.</li> <li>- Create new photonic materials from genetically engineered bacteriorhodopsin to improve optoelectronics and greatly increase information storage density.</li> <li>• 23904 - Develop algorithms for efficient multicast distribution and broadcasting, and for scalable routing in very large tactical mobile communications networks.</li> <li>- Model physical and operational phenomena for Army applications such as fluid dynamics for ballistics and rotorcraft, and armor penetration mechanics.</li> <li>- Investigate combustion thermal management in ultra-low heat rejection environments to improve propulsion in Army vehicles.</li> <li>- Develop revolutionary devices to solve several types of “unsolvable” problems through quantum computational analysis.</li> <li>- Develop simulation models of contaminant sorption and degradation processes for insertion into the DoD Groundwater Model System.</li> <li>• 3000 - Vehicle Mobility Research to be executed IAW FY00 Appropriation Conference Report</li> <li>• 1196 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> <li>Total 50382</li> </ul> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 24881 - Synthesize moldable rigid-rod optical polymers for exceptionally rugged, cheap optical components for targeting and communications systems.</li> <li>- Develop photocatalytic methods to decompose chemical agents.</li> <li>- Conduct research in self-assembly 3D photonic band gaps for potential application to single photon communications.</li> <li>- Conduct research in thermophilic organisms to create heat resistant enzymes for use as catalysts in industrial chemical reactions for synthesis and processing of Army materiel.</li> <li>• 26678 - Design of novel access protocols needed to support multimedia traffic streams for mobile communications networks.</li> <li>- Conduct advanced computational research to address problems in robotics, autonomous navigation and battle management.</li> <li>- Explore the feasibility of smart active/passive structural damping control utilizing magnetorheological fluid based dampers for stability augmentation of bearingless helicopter rotor blades.</li> <li>- Develop durable ice-phobic coatings to prevent ice build up on antennas, rotor blades and power lines.</li> <li>Total 51559</li> </ul>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AH66</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AH66 Advanced Structures Research	1167	1409	1463	1508	1523	1534	1543	Continuing	Continuing

**Mission Description and Justification:** This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic and aeromechanical stability; helicopter vibration (rotating and fixed systems); design and analyses of composite structures with crashworthiness as a goal; and the control of aircraft interior noise levels. These areas enable the evolution of design tools for improved helicopter structures and dynamic response. This structures-focused research includes reductions in vehicle vibratory loads, improved vehicle stability, advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, and the long-term maturation of an integrated stress-strength-inspection technology. These advancements will extend service life, reduce maintenance costs, and enhance the durability of existing and future Army vehicles. The improved tools and methods will enable the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms, and ultimately result in safer, more affordable vehicles. As agreed under Project Reliance, this is the only project for rotorcraft and ground structures basic research within the DoD. No related effort is being conducted within DoD.

**FY 1999 Accomplishments:**

- 1167 - Provided improved multiblade formulation for comprehensive analysis, validated dynamic and aeroelastic predictions for gimbaled tiltrotor; and under a CRDA with Penn State, extended aeroelastic-tailoring studies for soft-inplane tilt rotor systems.
- Published test standards to measure delamination onset and fracture toughness of composite laminates, and conducted research on a probabilistic method for analyzing low velocity impact resistance in composite panels.
- Conducted fatigue analysis for arbitrary flexbeam layup under combined tension/torsion loads, and investigated 3D damage primitives for matrix crack induced delamination failures.

Total 1167

**FY 2000 Planned Program:**

- 1402 - Generate an experimental design of the wind tunnel test of twist actuated active rotor system 'open loop' configuration.
- Research advanced smart structure actuator with improved performance and reduced cost
- Implement tiltrotor analytical model including power train dynamics and explore vibration reduction potential analyses.
- Publish results of actively controlled stability augmentation on tiltrotor configuration, and correlate with predictions from several analytical methods.
- Verify damage resistance and residual strength models for low velocity impact damage in composite panels.
- Research 3D finite element analysis with coupled tension/torsion loading to predict strength and life of flexbeam laminates.

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>		PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b> PROJECT <b>AH66</b>
<p align="center">- Investigate structural parameters that influence damage progression.</p> <p><b>FY 2000 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>- Extend Mode II &amp; III and Mixed Mode I &amp; II delamination fracture criteria to include fatigue durability.</li> <li>• 7 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 1409</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1463 - Evaluate forward flight characteristics in wind tunnel test of twist actuated active rotor system in 'open loop' configuration.</li> <li>- Investigate experiment design of 2<sup>nd</sup> wind tunnel tests of twist actuated active rotor system 'closed loop' configuration.</li> <li>- Incorporate active control and smart material analytical models into comprehensive analysis.</li> <li>- Investigate probabilistic method for designing low velocity impact resistant composite panels.</li> <li>- Conduct research in fatigue analysis for arbitrary flexbeam layup under combined tension and cyclic torsion loading.</li> <li>- Investigate improved damage growth predictions to better understand interactions between structural components such as skin and stringers.</li> <li>- Prepare draft test standards for Mode II &amp; III and Mixed Mode I &amp; II delamination onset criteria for fatigue durability of unidirectional composite laminates.</li> </ul> <p>Total 1463</p>		
Project AH66		<p align="center">Page 24 of 57 Pages</p> <p align="right">Exhibit R-2A (PE 0601102A)</p>



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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BH67</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BH67 Environmental Research - Army Materiel Command	3092	3507	3570	3631	3696	3762	3828	Continuing	Continuing

**Mission Description and Justification:** This project focuses basic research on innovative technologies for both industrial pollution prevention (P2) that directly supports the Army industrial base and for non-stockpile chemical warfare (CW) site remediation. The objective of the pollution prevention work is to invest in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater. The goal is to reduce the cost of remediating a site by at least 50% verses the use of conventional methods. Pollution prevention thrusts include: environmentally acceptable advanced non-radioactive, non-toxic and lightweight alternative structural materials to enhance weapon system performance; substitutes for ozone-depleting chemicals as solvents, refrigerants, and firefighting agents for military unique applications; energetic synthesis and process improvements to eliminate the use of hazardous materials and to minimize the generation of wastes from manufacturing operations; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. This project is linked to the Tri-Service Environmental Quality R&D Strategic Plan and addresses environmental technology requirements addressed in that plan.

**FY 1999 Accomplishments:**

- 1230 - Fabricated and examined specimens prepared with wire-wrapped, solid cylindrical, coating targets.
  - Characterized, evaluated, and validated a model of a Cylindrical Magnetron Sputtering (CMS) device. Identified required modeling and started acquiring and developing thermal, surface and plasma codes.
  - Demonstrated that the hydration step could be eliminated in the CL-20 manufacturing process.
  - Reduced the production of a carcinogenic by-product of the dinitrotoluene manufacturing process by 95%, cutting the total process waste by 25%.
  - Identified supercritical fluids that solubilize various candidate organic polymer binders used in pyrotechnic compounds and investigated parametrics for coating magnesium powders with polymer binder dissolved in supercritical fluid.
  - Demonstrated that oriented single crystal tungsten may be a potential replacement for depleted uranium in anti-armor penetrators.
  - Broke out sub-tasks to Small Business Research Firms for assistance in completing the above accomplishment.
- 649 - Structural, thermal stability, and corrosion resistance studies of Self-Assembled Monolayer (SAM) coatings were performed. SAMs can be applied in an environmentally benign process, and can be removed with minimal volatile organic chemicals and recycled.
  - Modified aqueous based coatings to optimize their functional properties to accelerate chemical/biological warfare agent degradation.
  - Discovered that hydrogen and oxygen atomic plasma may potentially be used for an environmentally benign CARC-type paint removal process.

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	
		PROJECT <b>BH67</b>
<p>- Completed supercritical fluid extraction recovery studies on nitroguanidine (NQ) in an effort to develop a safe, cost-effective technique to demil triple-base propellants that allows recovery of all three ingredients (NQ, nitroglycerine (NG) and nitrocellulose).</p> <p><b>FY 1999 Accomplishments: (continued)</b></p> <ul style="list-style-type: none"> <li>464 - Used a nondestructive ion beam-based instrument to evaluate the erosive elemental interaction of combustion gases with gun tube alloys/coatings and correlated the results with erosion models. Supports an effort in the ARDEC Green Gun Barrel program.</li> <li>649 - Completed environmentally benign degradation methods for Non-Stockpile Warfare Agents.</li> <li>- Developed a method to synthesize spider silk in large quantities using genetic engineering processes.</li> <li>- Produced nanocomposites with improved thermal properties and no loss in mechanical or biodegradable properties.</li> <li>- Produced large ceramic crystals for aqueous solutions without use of high temperatures or pressures.</li> <li>- Completed research on improved biodegradability of oils treated with biosurfactants.</li> <li>- Completed research on bioengineering of emulsifiers.</li> <li>- Completed research on thermally labile paint primers for solventless paint removal.</li> <li>- Completed research for catalytic treatment of contaminated shells in the continuation of life-cycle demil technologies.</li> </ul> <p>Total 100 3092</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>3432 - Optimize the environmentally benign CL-20 synthesis process for use in bench scale evaluation.</li> <li>- Develop model and test large caliber Cylindrical Magnetron Sputtering target configurations.</li> <li>- Evaluate biodegradable materials for incorporation in montmorillonite clay nanocomposites produced by melt extrusion (solvent-free) methods.</li> <li>- Complete studies of self-assembled monolayer-topcoat adhesion and the use of plasma surface treatment for improved adhesion.</li> <li>- Develop Soil Ecotoxicological Database for labile CW agent compounds and related compounds in soil, based on soil bioassay measurements.</li> <li>- Develop an economical manufacturing process for single crystal tungsten alloys and validate the performance of single crystal tungsten penetrators.</li> <li>- Develop supercritical fluid parameters for processing pyrotechnic binders.</li> <li>75 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 3507</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>3570 - Produce CL-20 and military grade 2,4-dinitrotoluene at bench scale using new environmentally benign processes.</li> <li>- Apply selected coatings to medium and large caliber gun tubes that will be test fired.</li> <li>- Characterize microstructural and performance properties of ceramic materials produced by biomimetic processes.</li> <li>- Optimize soil ecotoxicological screening bioassays and predictive capabilities for labile CW agent compounds in soils.</li> <li>- Compare the chemical resistance and physical/thermal properties of monolayer topcoats to with heavy-metal based primer-topcoat systems.</li> </ul> <p>Total 3570</p>		
Project BH67		Exhibit R-2A (PE 0601102A)

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AH68</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AH68 Processes in Pollution Abatement Technology	349	368	374	380	387	395	402	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project provides fundamental understanding of the physical, chemical and biological properties and mechanisms that control the degradation and treatment of hazardous wastes on military installations. This research is used to obtain basic technical information necessary for the design of treatment systems for both cleanups of existing hazardous waste sites and control of future hazardous waste generation. Wastes of concern include explosives, propellants, chemical agents and smokes. This project supports applied research efforts in Program Element 0602720A, Projects AF25 and DO48.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 349 - Determined factors regulating enzymatic degradation of explosives, characterized DNA for regulation and production, and developed conceptual model for regulation. (WES)</li> <li>- Completed minimal growth requirements for bacteria involved with destruction of energetic wastes. (CERL)</li> </ul> <p>Total 349</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 358 - Produce enzymes responsible for degradation, develop basic processes for isolating and characterizing them, and isolate and characterize the enzymes. (WES)</li> <li>- Characterize the bacterial nitroreductase used for degrading nitramine and nitroaromatic explosives. (CERL)</li> <li>• 10 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 368</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 374 - Determine physiological conditions necessary for optimum enzyme activity, establish effectiveness of cell-free enzyme systems and develop basic processes to obtain enzyme stability and effectiveness. (WES)</li> <li>- Determine the role of hydrogen cycling in explosive nitroreductase enzymes. (CERL)</li> </ul> <p>Total 374</p>									
<div style="display: flex; justify-content: space-between;"> <span>Project AH68</span> <span>Page 27 of 57 Pages</span> <span>Exhibit R-2A (PE 0601102A)</span> </div>									

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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BS04</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS04 Military Pollutants and Health Hazards	555	621	631	640	653	665	678	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project provides basic research in innovative, less costly, and less time consuming toxicity assessment methods for determining potential human health and environmental effects of military-unique hazardous wastes and chemicals, including explosives, propellants, and smokes. These new testing techniques will help to prioritize hazardous waste and waste treatment technologies and screen new Army chemicals for potential toxic effects. The work is conducted at U.S. Army Center for Environmental Health Research (CEHR) and U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM).</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 555 - Developed intra-laboratory validation of specific sentinel environmental toxicity hazard assessment methods. (CEHR)</li> <li style="padding-left: 20px;">- Identified additional sentinel biomonitoring systems for toxicity hazard assessment. (CEHR)</li> <li style="padding-left: 20px;">- Transferred intra-laboratory validated sentinel methods to PE 0602720A, Project A835 for interlaboratory and field validation and inclusion in an integrated toxicity hazard assessment package. (CEHR)</li> </ul> <p>Total 555</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 605 - Identify sentinel biomonitoring systems for neurobehavioral toxicity hazard assessment. (CEHR)</li> <li style="padding-left: 20px;">- Conduct intralaboratory validation of specific sentinel environmental toxicity hazard assessment methods for immunotoxicity and reproductive toxicity. (CEHR)</li> <li style="padding-left: 20px;">- Transfer intra-laboratory validated sentinel methods for immunotoxicity assessment to PE 0602720A, Project A835 for further inter-laboratory and field validation and inclusion in an integrated toxicity hazard assessment package. (CEHR)</li> <li>• 16 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 621</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 631 - Identify sentinel biomonitoring systems for neurobehavioral toxicity hazard assessment. (CEHR)</li> <li style="padding-left: 20px;">- Improve and validate specific sentinel environmental toxicity hazard assessment methods for immunotoxicity and reproductive toxicity. (CEHR)</li> <li style="padding-left: 20px;">- Improve and validate sentinel environmental toxicity hazard assessment methods for neurobehavioral. (CEHR)</li> <li style="padding-left: 20px;">- Transfer intra-laboratory validated sentinel methods for reproductive toxicity assessment to PE 0602720A, Project A835 for further inter-laboratory and field validation and inclusion in an integrated toxicity hazard assessment package. (CEHR)</li> </ul> <p>Total 631</p>									
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>BS13</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS13 Science Base/Medical Research Infectious Disease	8784	8954	9185	9385	9567	9742	9916	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project funds basic research on medical countermeasures for naturally occurring diseases which are militarily significant due to their potential impact on military operations. Establishment of medical countermeasures will protect the force from infection and sustain operations by preventing hospitalizations and evacuations from the theater of operations.</p> <p><b><u>FY 1999 Accomplishments:</u></b></p> <ul style="list-style-type: none"> <li>• 4020 - Characterized the immune responses to leading candidate malaria vaccines to determine how to improve these candidates.              - Almost completed sequencing of <i>Plasmodium falciparum</i> Chromosome 14. Began to develop strategy for bioinformatics system to identify gene targets from the sequence data for use in malaria vaccine development and targeted drug development programs.              - Identified five different target proteins for structure-based drug design of novel antimalarial drugs.              - Exploited emerging advanced technologies to discover methods to improve detection of drug-resistant malaria and to design new drugs.</li> <li>• 1091 - Determined the best approach for development of a vaccine against <i>Shigella dysenteriae</i>, one of the three major <i>Shigella</i> bacterias that cause diarrhea.              - Identified components for a rapid test to identify <i>Shigella</i> in personnel with diarrhea.              - Explored new vaccine delivery systems, vaccine strains, and animal models to test vaccines to prevent enterotoxigenic <i>Escherichia coli</i> (ETEC) diarrhea. Explored methods to reduce the virulence of live <i>Campylobacter</i> strains for use as vaccines.</li> <li>• 1493 - Identified and characterized potential components for candidate dengue virus vaccines and diagnostic tests.              - Constructed dengue nucleic acid candidate vaccines.              - Identified and characterized potential components of future tests for hantavirus.              - Assessed immune responses to candidate hantavirus vaccines in mice.              - Conducted surveillance for hantaviruses in South America and South East Asia.</li> <li>• 2180 - Characterized isolates of hepatitis E virus obtained worldwide to establish requirements for candidate vaccines to protect soldiers in diverse regions.              - Confirmed the occurrence of natural drug resistance in <i>Orientia tsutsugamushi</i>, the cause of scrub typhus.              - Conducted molecular studies of candidate vaccines made from Group B <i>Neisseria meningitidis</i> designed to protect recruits against bacterial meningitis.              - Explored new procedures and reagents for improvement of far-forward diagnosis of infectious diseases.              - Synthesized modified versions of a new candidate insect repellent.              - Devised rapid assays for the detection of insects that carry <i>Leishmania</i> and mosquitoes that carry dengue virus.</li> </ul>									
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BS13</b>
Total 8784  <b>FY 2000 Planned Program:</b> <ul style="list-style-type: none"> <li>• 3985 - Further identify and characterize the mechanisms of protective immunity and targets of protective immune responses against malaria.             <ul style="list-style-type: none"> <li>- Discover additional malaria proteins that could be useful vaccine components.</li> <li>- Devise tests that can predict if a person who received a vaccine would be protected against malaria.</li> <li>- Devise strategies for rapidly exploiting the malaria genetic sequence for vaccine and drug development.</li> <li>- Prepare <i>Plasmodium vivax</i> malaria DNA for sequencing.</li> <li>- Identify candidate antimalarial drugs that have been prepared by chemical synthesis or isolated from plants.</li> <li>- Identify techniques for growing <i>P. vivax</i> malaria in the laboratory and testing drugs against these organisms to determine if the drugs are effective.</li> <li>- Employ computer modeling techniques to design antimalarial drugs.</li> <li>- Identify malaria proteins that could be targets of drugs and use this information to design new drugs.</li> <li>- Create a deployable field test to detect if malaria parasites are resistant to currently used drugs and use it to conduct surveillance for drug-sensitivity patterns of malaria in diverse geographic regions.</li> </ul> </li> <li>• 1308 - Identify and characterize how enteric bacteria cause diarrheal disease and how the disease process could be interrupted; use this information to help design vaccines.             <ul style="list-style-type: none"> <li>- Construct <i>Campylobacter</i> vaccine candidates.</li> <li>- Analyze available DNA sequence data of diarrheal-causing bacteria (<i>Campylobacter</i>, <i>Shigella</i>, and ETEC) to look for similarities among these different species to find potential broadly protective vaccine components.</li> <li>- Construct combined <i>Campylobacter</i>, <i>Shigella</i>, and ETEC vaccines.</li> </ul> </li> <li>• 1938 - Identify factors that predict safety and a long-lasting immune response to enable selection of the best dengue vaccine candidate for further development.             <ul style="list-style-type: none"> <li>- Assess the mechanisms of disease development in viral hemorrhagic fever to provide insights for discovery and design of vaccines or other countermeasures.</li> <li>- Construct antibodies in monkeys to evaluate the ability to protect animals from viral hemorrhagic fevers (VHF).</li> <li>- Improve the capability to rapidly identify VHF agents in the field and to provide definitive confirmation in reference labs.</li> <li>- Investigate VHF outbreaks to validate assays and obtain fresh field samples for viral isolation and analysis of immune response.</li> <li>- Determine the level of antibody necessary to prevent HEV disease. Complete characterization of human immune responses to HEV infection, disease, and vaccine.</li> <li>- Conduct epidemiological studies of HEV and analysis of virus types in Asia and Africa.</li> <li>- Sustain or refute the presence of hepatitis E disease among humans in Latin America using virus detection as basis for diagnosis.</li> <li>- Characterize animal carriers of HEV and the HEV viruses they carry.</li> <li>- Characterize human and viral factors leading to severe hepatitis E.</li> </ul> </li> </ul>		
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<ul style="list-style-type: none"> <li>- Establish the range of differences in immune stimulation among the different strains of the organism that causes scrub typhus.</li> <li>- Define a group of <i>Orientia tsutsugamushi</i> isolates (the cause of scrub typhus) that combined in a vaccine would provide a broad range of protection.</li> </ul> <p><b>FY 2000 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>- Prepare strain-specific antigens from multiple isolates of <i>Orientia</i> for use in the development of a scrub typhus vaccine protective against many strains.</li> <li>- Prepare at least one vaccine candidate (e.g., recombinant DNA) and evaluate its ability to protect mice against infection with the same strain of <i>Orientia</i>.</li> <li>- Assess the immune responses to candidate hantavirus vaccines in mice.</li> <li>- Characterize and evaluate factors related to immunity in monkey and human infection with hantavirus.</li> <li>• 1574 - Conduct surveillance for hantaviruses in South America and Southeast Asia.</li> <li>- Analyze human immune response to specific components of candidate vaccines for Group B meningococcus.</li> <li>- Identify three additional vaccine strain candidates with different protein and carbohydrate components and genetically modify them to make them nontoxic for use as vaccines.</li> <li>- Conduct risk assessment and identification of natural reservoirs/carriers (vectors) of diseases other than dengue.</li> <li>- Study insect vectors and their role in spreading infectious diseases of military significance.</li> <li>- Conduct preliminary development of a field device for detecting malaria parasites in insect vectors.</li> <li>- Devise methods to process clinical samples that allow the purification of DNA molecules in less than 30 minutes.</li> <li>- Construct test components to detect DNA or RNA for use in diagnosing relevant diseases such as malaria, dengue, diarrhea, and hemorrhagic fevers.</li> <li>• 149 Small Business Innovative Research/Small Business Technology Transfer Research Programs.</li> <li>Total 8954</li> </ul> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 3166 - Begin systematic screening of the DNA sequences of the malaria parasite to identify additional <i>P. falciparum</i> candidate vaccine antigens.</li> <li>- Complete the DNA sequence of <i>P. falciparum</i>, the cause of serious malaria in military personnel.</li> <li>- Begin sequencing the DNA of <i>P. vivax</i>, the other major causes of malaria in military personnel.</li> <li>- Determine unique <i>P. falciparum</i> gene targets that could be incorporated into a diagnostic test to detect drug-resistant malaria.</li> <li>- Identify potential populations for field testing a drug for treatment of multidrug-resistant malaria.</li> <li>- Discover new antimalarial drug candidates. Continue efforts to define mechanism(s) of antimalarial drug resistance.</li> <li>• 1545 - Identify potential components of a combined <i>Shigella</i> vaccine effective against multiple strains of <i>Shigella</i>. Identify the best ETEC candidate components for inclusion in a combined vaccine to prevent diarrhea caused by multiple bacterial species including ETEC, <i>Shigella</i>, and <i>Campylobacter</i>.</li> <li>- Identify components of candidate <i>Campylobacter</i> vaccines and vaccine approaches that would be compatible with the <i>Shigella</i> and ETEC components of a combined diarrhea vaccine.</li> <li>- Identify DNA reagents for <i>Shigella</i>, <i>Campylobacter</i>, and ETEC that will be compatible with the common diagnostic platform for diagnosing diarrhea in forward areas.</li> </ul>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BS13</b>
<p><b>FY 2001 Accomplishments: (continued)</b></p> <ul style="list-style-type: none"> <li> <div>4474</div> <div>- Identify immune responses to dengue infection to help evaluate efficacy of candidate dengue vaccines.</div> <div>- Complete a risk assessment of chigger and tickborne diseases to military personnel.</div> <div>- Conduct research to select the best vaccine candidate for prevention of TBE in military service members.</div> <div>- Define the best strategy for acquisition of a vaccine to prevent tickborne encephalitis (TBE).</div> <div>- Assess and define the operational impact of disease caused by hemorrhagic fever viruses and other highly lethal viruses such as Lassa.</div> <div>- Define the range of immunological differences among <i>Orientia</i> isolates.</div> <div>- Prepare strain-specific antigens from multiple isolates of <i>Orientia</i> for use in the development of a scrub typhus vaccine.</div> <div>- Prepare at least one vaccine candidate (e.g., recombinant DNA) and evaluate its ability to protect mice against an infection challenge from the strain of <i>Orientia</i> used to prepare the vaccine.</div> <div>- Prepare proteins and/or carbohydrates that are common to all strains of Group B meningococcus that can potentially be used to protect against all strains.</div> <div>- Complete establishment of a system for worldwide surveillance of insecticide resistance.</div> </li> </ul> <p>Total      9185</p>		
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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BS14</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS14 Science Base/Combat Casualty Care Research	3517	3949	4042	4122	4196	4269	4340	Continuing	Continuing

**Mission Description and Justification:** This project conducts research to understand the basic mechanisms of combat-related trauma. This research identifies trauma-related topic areas for exploratory techniques and the experimental models necessary to support in-depth trauma research studies. This research is the basis for the advancement of trauma treatment and surgical procedures to extend the time of death due to bleeding following trauma injury, minimize lost duty time from minor battle and nonbattle injuries, and provide military medical capabilities for far-forward medical/surgical care of battle and nonbattle injuries.

**FY 1999 Accomplishments:**

- 1930 - Conducted research on formulations to extend the liquid storage time span of red blood cells to 10 weeks to enhance far-forward blood supplies.
- Began studies to characterize temperature and physical properties of plasma storage bags to decrease product losses during shipping.
- Investigated the efficacy of dressings designed to staunch massive bleeding in combat casualties.
- Established a clinically relevant model of combined head injury and hemorrhage as a model to assess optimal resuscitation methods.
- Performed research into fundamental aspects of severe hemorrhage to determine requirements for aggressive resuscitation.
- Investigated biologics/pharmaceuticals to prevent injury in the brain, spinal cord, and other organs after resuscitation. The biologics/pharmaceuticals studied include nerve cell sodium channels and the proteasome system and drugs including dihydrolipoic acid, ANH 649, glutamate, nicotinamide adenine dinucleotide, and a thyroid-releasing, hormone-releasing analog.
- 443 - Identified potential antimicrobial peptide compounds and tested their efficiency in cell cultures as a step in developing an antiplaque and anticaries dental protective formulations.
- 419 - Established cell culture system to test a molecular biology based biologic, antisense DNA, that is directed against bronchial epithelial mucus genes to block the excessive secretion of mucus that occurs after smoke inhalation.
- Investigated methods for the diagnosis and repair of armored leg injuries including bone, blood vessels, and skin.
- Demonstrated that neurotoxins from marine snails are effective neuroprotective agents when used in low doses.
- 725 - Developed gene analysis methods to assess cytokine contribution to secondary tissue damage that occurs after trauma.
- Verified the sensitivity of noninvasive sensors designed to monitor physiological parameters for the diagnosis and treatment of casualties.
- Investigated optimal sensor configuration for monitoring trauma casualties.

Total 3517

**FY 2000 Planned Program:**

- 506 - Develop a stable antiplaque and anticaries peptide for incorporation into the U.S. military field ration.
- Evaluate the feasibility of developing an anticaries vaccine to reduce dental casualties far forward.

Project BS14

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BS14</b>
<p><b>FY 2000 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>• 246 - Investigate the degree of fluid resuscitation that is optimal after severe hemorrhage.</li> <li>• 1783 - Examine concentrated fluid therapy as a treatment for combined brain trauma and hemorrhage. <ul style="list-style-type: none"> <li>- Assess the effects of oxygen inhalation on heart and blood vessels after hemorrhage.</li> <li>- Compare heart and blood vessel and metabolic responses in controlled and uncontrolled hemorrhage to develop trauma-specific resuscitation protocols.</li> <li>- Test a resuscitation protocol using the biologic compound polynitroxyl hetastarch for resuscitation after combined brain trauma and hemorrhage.</li> <li>- Test complement activation inhibitors as therapeutics to prevent organ injury after resuscitation.</li> <li>- Investigate the function of cellular signaling as a method to reduce cellular inflammation after resuscitation.</li> <li>- Assess monitoring of heartbeat variability as a method to estimate hemorrhagic status.</li> <li>- Determine inflammation potential of supernatants from liquid red blood cell storage systems.</li> <li>- Compare efficacy of competing methods that are used to prepare plasma products with enhanced shelf lives.</li> <li>- Test testosterone as a therapy to enhance survival after severe trauma and infection.</li> </ul> </li> <li>• 411 - Investigate structural properties of Haversian bone to develop methods to enhance fracture healing. <ul style="list-style-type: none"> <li>- Evaluate efficacy of hydroxyapatite- and chlorhexidine-coated stainless steel fixator pins in preventing infection in bones.</li> <li>- Investigate total intravenous anesthetic as a method to improve battlefield anesthesia.</li> </ul> </li> <li>• 925 - Evaluate the use of cultivated skin cells to replace skin grafts for burns. <ul style="list-style-type: none"> <li>- Test the combination of anti-rejection drugs synthetic MHC peptide, CTLA4-IG, and anti-CD154 as a treatment to prevent skin graft rejection after burns.</li> <li>- Evaluate an experimental imaging system used to assess depth of skin injury after burns or trauma.</li> </ul> </li> <li>• 78 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.</li> </ul> <p>Total 3949</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 399 - Screen antiplaque and anticaries peptides in appropriate test models.</li> <li>• 1268 - Conduct research into optimal resuscitation protocols to treat casualties after severe hemorrhage. <ul style="list-style-type: none"> <li>- Conduct research into the diagnosis and treatment of blast, behind armor, and other blunt trauma.</li> </ul> </li> <li>• 504 - Compare computerized programs that integrate sensor inputs to allow far-forward detection of lung injury. <ul style="list-style-type: none"> <li>- Investigate nerve cell receptor-specific analgesia and pain relief to increase return-to-duty capabilities far forward.</li> <li>- Test a molecular biology-based biologic termed antisense DNA that is directed against mucus genes for its ability to inhibit excess mucus secretion in preclinical smoke inhalation models.</li> </ul> </li> <li>• 1871 - Evaluate pharmaceutical treatments to counter central nervous system injury that occurs after an initial trauma.</li> </ul>		
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BS14</b>
<p>- Evaluate animal models to assess efficacy of pharmacologic therapies directed against injury that occurs after resuscitation from severe hemorrhage.</p> <p><b>FY 2001 Planned Program: (continued)</b></p> <p>- Formulate second generation plasma products that incorporate improvements in stability and weight.</p> <p>Total            4042</p>		
<p>Project BS14</p> <p align="center"><i>Page 35 of 57 Pages</i></p> <p align="right">Exhibit R-2A (PE 0601102A)</p>		

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BS15</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS15 Science Base/Army Operational Medecine Research	9026	5353	5495	5617	5725	5827	5928	Continuing	Continuing

**Mission Description and Justification:** The scientific and technical objectives for this project focus on physiological and psychological factors limiting soldier effectiveness, and on the characterization of health hazards generated by military systems and resulting from military operations. Research is conducted on militarily relevant aspects of environmental physiology and the neurobehavioral aspects of stress. The hazards of exposure to several classes of non-ionizing radiation, directed energy, blast, jolt, vibration, noise, and toxic industrial chemicals as environmental contaminants are also investigated under this project. Specific tasks include delineating injury and effect thresholds, mechanisms, and sites of action. Emphasis is on protection, sustainment, and enhancement of the physiological and psychological capabilities of military personnel under combat operations in all environments. The six main thrust areas include neuromodulation of stress and cognition, metabolic regulation, control of regional blood flow, oxidative stress interventions, tissue remodeling/plasticity, and biomechanical/biodynamic mechanisms of injury. A portion of this research supports the Science Research Objective (SRO) on "Enhancing Soldier Performance."

**FY 1999 Accomplishments:**

- 4645 - Demonstrated that carbohydrate supplements enhance physical and mental performance during simulated operational Special Forces unit combat operations; demonstrated that creatine supplements increase muscle endurance and recovery during knee extension exercise.  
 - Explored differences in immune function in animals during exposure to stress; conducted animal studies of sleep deprivation to identify strategies that could influence learning during periods of severe stress.  
 - Examined energy expenditure in a variety of military training exercises/operations, documenting high levels of energy use among warfighters, including U.S. Marines and Army Personnel.
- 991 - Validated a rat model of human hypothermia.  
 - Demonstrated a quantitative index of the inflammatory response induced by endotoxin, which is increased by a variety of stressors including rewarming after cold injury.  
 - Discovered that hyperthermia-induced leakage of fluids from the circulatory system was reduced by the administration of a calcium-blocking drug, suggesting that this may have beneficial effects on heat injury at the cellular level.
- 1941 - Explored the feasibility of prognostic indicators of impending bone injury in a study of Marines at Parris Island.  
 - Convened an international symposium to review vertebrate chemoreceptor oxygen sensing mechanisms, adaptation to altitude, and potential for novel bioengineered oxygen sensing applications.  
 - Identified the presence of a pro-inflammatory transcription factor in a nonmammalian model, as an in vivo model to assess militarily relevant immunotoxicity.  
 - Discovered alterations in stress hormones for military personnel engaged in survival, evasion, resistance, and escape training, suggesting potential indicators of psychological stress levels.

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**UNCLASSIFIED**

<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BS15</b>
<p><b>FY 1999 Accomplishments: (continued)</b></p> <ul style="list-style-type: none"> <li> <div> <div>1449</div> <div> - Identified the effects of single versus multiple subthreshold blast overpressure exposures to lung, heart, brain, kidney, liver, and the gastrointestinal tract.  - Developed a nonhuman primate model of nerve fiber degeneration important for preventing vision loss after retinal laser injury.  - Identified changes in the choroidal vasculature after q-switched neodymium laser exposure using noninvasive imaging techniques.  - Evaluate the ability of the optical switch to protect against laser-induced retinal injury from micro- and nanosecond pulsed lasers.  - Demonstrated decreased activity in the brain area responsible for complex task performance during sleep deprivation.  - Assessed newly developed tests of visual performance (digital imaging, small letter contrast test, and color acuity test) to determine if they are useful in evaluating macular disease, glaucoma, and diabetic retinopathy. </div> </div> </li> </ul> <p>Total      9026</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>1407</div> <div> - Explore effects of an amino acid dietary supplement on muscle metabolism and strength following a protracted resistance exercise training program in women (an Army Strategic Research Objective, SRO).  - Determine the ability of vitamin/antioxidant supplements to prevent or improve recovery from over-use muscle injury or preserve lean body mass during sustained operations (SRO). </div> </div> </li> <li> <div> <div>1227</div> <div> - Identify biochemical mechanisms and functional consequences of overtraining in soldiers with prolonged physical exertion and other operational stress (SRO).  - Complete studies on oxidative stress and the immune response.  - Investigate methods for measuring changes in gene expression in animals following exposure to militarily relevant chemicals. </div> </div> </li> <li> <div> <div>995</div> <div> - Investigate mechanisms of heat acclimation strategies to optimize thermoregulation and tissue protection.  - Investigate the mechanisms of various interventions (hypertonic saline/dextran and flunarizine) to reduce hypothermia and rewarming injury in a rat model of human hypothermia (SRO). </div> </div> </li> <li> <div> <div>1637</div> <div> - Determine noninvasive neuroendocrine markers of mental performance (marksmanship, sensory processing, attention, and vigilance) in an operationally stressful environment.  - Identify predictors of operational task performance with sleep deficit based on the relative contribution of a learning component using data from human sleep dose study (SRO).  - Explore adaptive strategies of humans to laser exposure for inclusion in laser battlefield models and a virtual reality training system for soldiers.  - Characterize laser-induced ocular trauma and treatment efficacy by advanced ocular imaging (optical coherence tomography, enhanced resolution scanning laser ophthalmoscopy) with simultaneous functional assessments. </div> </div> </li> <li> <div> <div>87</div> <div> - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs. </div> </div> </li> </ul> <p>Total      5353</p>		
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>
BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>BS15</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1606 - Explore approaches to reduce metabolic water requirements through thermoregulatory and osmoregulatory mediators (SRO). <ul style="list-style-type: none"> <li>- Investigate the effects of caffeine and/or ephedrine on metabolic rate and performance in cold environments (SRO).</li> <li>- Explore feasibility of modifying chemoreceptor oxygen sensing to simulate altitude to accelerate acclimation in hypoxia (SRO).</li> <li>- Evaluate and quantify the efficacy of cytokine antagonists as prophylaxes/therapies to heat injury/illness.</li> </ul> </li> <li>• 1723 - Discover mechanisms of stress fracture and the relationship to bone mineral density to determine if stress fracture incidence can be reduced through interventions to enhance bone mineral build-up (SRO). <ul style="list-style-type: none"> <li>- Model biophysical properties of human tissues for use in predictive injury models.</li> <li>- Evaluate methods for measuring gene expression in animals following exposure to militarily relevant chemicals and relate findings to toxicological outcomes.</li> </ul> </li> <li>• 2166 - Identify and quantify cytokines and other cellular mediators in sleep deprivation and extreme fatigue generated in adverse environments. <ul style="list-style-type: none"> <li>- Use positron emission tomography imaging to evaluate brain activity while performing cognitive tasks under sleep deprivation (SRO).</li> <li>- Assess potential therapeutics against blast-induced neuronal damage in animal models.</li> <li>- Investigate pharmacological intervention strategies to enhance performance in a stressful environment.</li> </ul> </li> <li>• - Explore the timing of pharmacological interventions for treatment of laser-induced retinal injury.</li> </ul> <p>Total 5495</p>		
Project BS15	Page 38 of 57 Pages	Exhibit R-2A (PE 0601102A)

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BS17</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS17 Molecular Biology/Military HIV Research	374	431	439	445	482	642	661	Continuing	Continuing

**Mission Description and Justification:** This project provides for basic research for early diagnosis and identification of technologies to design prevention and treatment of human immunodeficiency virus (HIV). The present emphasis is on identification and comparison of HIV strains from many geographical locations, characterization of etiologic agents, and definition of tests for epidemiological surveys to design a vaccine to prevent disease. Current policy prohibits OCONUS assignments of antibody positive service members. A safe and effective vaccine for prevention of infection and intervention will permit all service members to become worldwide deployable.

**FY 1999 Accomplishments:**

- 374 - Identified complex protein candidates for HIV vaccines.
- Characterized the immune response against complex protein vaccine candidates.
- Explored DNA vaccine candidates.

Total 374

**FY 2000 Planned Program:**

- 419 - Evaluate the importance of different HIV strains to determine which strains should be included in an HIV vaccine.
- Define ways to measure if an individual develops protective immune response to HIV vaccines, necessary for vaccine design.
- Analyze drug resistance among HIV-1 isolated from patients to establish drug treatment strategies for military dependents.
- 12 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.

Total 431

**FY 2001 Planned Program:**

- 439 - Evaluate new methodologies for exploration of HIV drug resistance mechanisms.

Total 439

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>								DATE <b>February 2000</b>	
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>BS19</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS19 Telemedicine Soldier Status Research	450	611	620	631	609	672	703	Continuing	Continuing

**Mission Description and Justification:** The purpose of this program is to perform research contributing to superior combat casualty care for troops through faster diagnosis and treatment while allowing on-site health care providers to consult with specialists worldwide. This work will focus on advancing the means to determine soldier physiological status and aiding medical diagnosis and treatment. A significant thrust area will work to ascertain the sensors most relevant to determine change in soldier physiological status.

**FY 1999 Accomplishments:**

- 142 - Began work to determine design improvements, with a view to delivering a slave telepresence microsurgery system to the Uniformed Services University of Health Sciences in FY 2000 for telepresence microsurgery system.
- 41 - Established human use protocols to test telesurgical mentoring systems in clinical trials for virtual reality assisted telesurgery system; established telecommunications links between Fort Detrick and Johns Hopkins University.
- 175 - Awarded contract, both to conduct market survey of ophthalmic fundus imaging equipment and to develop "benchmark" patient screening protocol for teleophthalmology for diabetic retinopathy screening.  
- Committed funding for basic technology development of a flexible ureteroscopic simulator for endoscopic simulator development, minimally invasive surgical research.
- 92 - Conducted research in Web-based consultation for medical specialties.

Total 450

**FY 2000 Planned Program:**

- 474 - Investigate training devices incorporating patient simulation, virtual reality, and computer-aided instruction to train care providers at all levels.
- 121 - Conduct research on predictive diagnostics for computer-assisted critical care and medical decision support to increase the capabilities of caregivers at far-forward localities.
- 16 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.

Total 611

**FY 2001 Planned Program:**

- 507 - Conduct research on training devices to train care providers at all levels.
- 113 - Conduct research on predictive diagnostics for computer-assisted critical care and medical decision support to enhance far-forward casualty care capabilities.

Total 620

Project BS19



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ARMY RDT&E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)								DATE <b>February 2000</b>	
BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>BS20</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BS20 Science Base Emerging Infectious Diseases	0	0	3975	0	0	0	0	3975	3975
<p><b><u>Mission Description and Justification:</u></b> This one year congressional project's scientific and technical objectives focus on speeding development of infectious disease threat countermeasures necessary to support operations in non-industrialized countries and those in which infrastructure has been damaged or destroyed. It will also fund the necessary research to counter the military operational impact of emerging infectious diseases.</p> <p><b>FY 1999 Accomplishments:</b> Project not funded in FY 1999</p> <p><b>FY 2000 Planned Program:</b> Project not funded in FY 2000</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 3975 - Perform and complete basic research to identify potential measures to counter the threat of emerging infectious diseases.</li> </ul> <p>Total 3975</p>									
<div style="display: flex; justify-content: space-between;"> <span>Project BS20</span> <span>Page 41 of 57 Pages</span> <span>Exhibit R-2A (PE 0601102A)</span> </div>									

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AT22</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AT22 Soil and Rock Mechanics	1654	1856	1887	1915	1952	1989	2028	Continuing	Continuing

**Mission Description and Justification:** Basic research in this project develops the fundamental knowledge base required by the Army in the field of civil engineering. Current emphasis is on: defining the constitutive behavior and penetration mechanics (including plastic deformation and microfracture mechanics) associated with projectile impact on complex geologic and structural materials; development of mathematical models needed for first principle analyses of explosive-induced ground shock and high-velocity projectile impact; development of analytic models and advanced construction materials for the design and construction of permanent or expedient operating surfaces both within CONUS and within a theater of operations; development of adaptive or responsive construction materials suitable for camouflage, concealment, and deception measures for fixed or semi-fixed assets; and determining and quantifying the non-linear, hysteretic response of deformable soils to transient loadings resulting from high-speed curvilinear vehicle maneuver. These technologies provide the basis for applied research to provide: analytical capabilities for mobility assessments; hardened battlefield positions, fixed facilities, and semi -fixed assets; multispectral camouflage, concealment, and deception for fixed facilities; and advanced vertical and horizontal construction materials in PE 0602784A, Project AT40.

**FY 1999 Accomplishments:**

- 1654 - Completed first-principle code calculations simulating oblique-impact long-rod penetration tests against concrete targets.
- Incorporated selected responsive/passive materials into/onto substrate host.
- Completed analytical models for predicting traffic distribution, cohesive soil moisture response, and compaction behavior.
- Developed analytic model describing influence of partial soil saturation on surface shear strength.

Total 1654

**FY 2000 Planned Program:**

- 1807 - Incorporate projectile erosion algorithms into penetration prediction codes.
- Determine appropriate combinations of responsive/passive composite materials for camouflage, cover, and deception as a function of environment and facility.
- Develop theoretical formulation for penetration of wheels into partially saturated soils during cross-country movement.
- Verify constitutive models for asphalt pavement materials and implement constitutive models for granular materials into an advanced pavement system model.
- 49 - Small Business Innovative Research / Small Business Technology Transfer (SBIR/STTR) Programs.

Total 1856

Project AT22
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>AT22</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1887 - Develop finite element interface algorithms for response of target joints and fractures to projectile penetration.</li> <li>- Develop experimental quantity of responsive/passive camouflage, cover, and deception material.</li> <li>- Model soil response to transient loading patterns of wheeled and tracked vehicles.</li> <li>- Evaluate pavement interface, load, dynamic response, and traffic distribution models.</li> <li>• - Determine physics of fiber-soil interaction that facilitates increased soil stability.</li> </ul> <p>Total 1887</p>		
<p>Project AT22</p> <p align="center"><i>Page 43 of 57 Pages</i></p> <p align="right">Exhibit R-2A (PE 0601102A)</p>		

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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>AT23</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AT23 Basic Research/Military Construction	1436	1549	1595	1619	1650	1682	1714	Continuing	Continuing

**Mission Description and Justification:** This project supports development of fundamental knowledge essential to develop the leap ahead technologies required to solve Army and Defense (via Project Reliance) unique problems in the planning, programming, design, construction, and sustainment of force projection platforms and energy and utility infrastructure to achieve the infrastructure cost reduction goals of the current national military strategy. This project supports exploratory development efforts in Program Element 0602784A, Projects AT41 and AT45. This project has significant dual-use application potential.

**FY 1999 Accomplishments:**

- 1436 - Developed collaborative engineering methodologies to enable asynchronous design and engineering of facilities.
- Characterized Electrical Time-Domain Reflectometry (ETDR) for evaluation of structural health of large concrete structures.
- Conducted 3D response analysis of steel buildings for seismic safety.
- Develop concepts for magnetostrictive patch structural health monitoring systems.

Total 1436

**FY 2000 Planned Program:**

- 1508 - Fundamental understanding of the behavior of structural connections under high cyclic loads (like earthquakes).
- Characterization of post-elastic responses of frame and shear walls to tri-directional earthquake loading.
- Models for determining structural health using ETDR techniques.
- 41 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..

Total 1549

**FY 2001 Planned Program:**

- 1595 - Develop theory for collaborative axiomatic designs.
- Develop and test models for force development in shape memory alloy (SMA) pre-/post-tensioned systems.
- Evaluate principles for infrastructure applications of functionally gradient materials systems that are multiple function layer-wise systems that can perform multiple sensor/actuator functions over a finite distance.

Total 1595

Project AT23
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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>AT24</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
AT24 Snow, Ice and Frozen Soil	1244	2164	1185	1203	1217	1227	1237	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project is the only focused DoD basic research program investigating the physical, chemical, and electrical properties of snow, ice, and frozen soil and characterization of dominant winter and cold regions processes impacting military materiel, operations, and facilities. It provides the knowledge base for exploratory development to support modeling and simulation and product improvements as well as leading to reduced life-cycle costs and increased readiness and operability in extreme cold, high altitude and seasonal winter conditions around the world. Products are directly input to PE 0602784A, Project AT42, as well as Navy and Air Force science and technology efforts, and form the basis for civilian applied research in these areas. It provides the fundamental knowledge base for developing concepts and approaches to upgrade materiel and doctrine for more effective performance in these challenging conditions. This work is managed by the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 1244 - Developed vectorized seismic wave propagation code for viscoelastic/porous media.</li> <li style="padding-left: 100px;">- Developed computer model to analyze ice properties derived from satellite microwave footprints.</li> <li style="padding-left: 100px;">- Developed procedures for mapping regional atmospheric icing.</li> </ul> <p>Total 1244</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1146 - Investigate small-scale heterogeneity for state-of-the-snow/ground modeling.</li> <li style="padding-left: 100px;">- Analyze spatial variability of icing processes relevant to communications and air operations.</li> <li style="padding-left: 100px;">- Determine efficiency of snow as a filter for chemical particulates.</li> <li>• 983 - Identify cold unique phenomena for Homeland Defense issues such as bio-terrorism and chemical agent releases.</li> <li>• 35 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..</li> </ul> <p>Total 2164</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1185 - Develop model for parameterizing turbulent energy exchange over snow.</li> <li style="padding-left: 100px;">- Develop statistical characterization of ice thickness relevant to winter operations.</li> <li style="padding-left: 100px;">- Broaden understanding of snow friction processes relevant to military operations.</li> </ul> <p>Total 1185</p>									
<div style="display: flex; justify-content: space-between;"> <span>Project AT24</span> <span>Page 45 of 57 Pages</span> <span>Exhibit R-2A (PE 0601102A)</span> </div>									

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>BT25</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
BT25 Environmental Research - Corps of Engineers	3908	4425	4503	4569	4656	4746	4838	Continuing	Continuing

**Mission Description and Justification:** This project provides the basic research needed to develop the technologies to address Army issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. The focus in restoration provides the basic knowledge needed to develop physical, chemical and biological technologies to clean up the Army's contaminated sites. In compliance and pollution prevention, efforts address knowledge gaps vital to maintaining compliance and preventing pollution at non-industrial installations. The focus in conservation is on landform and ecological modeling, the feasibility of development and propagation of resilient plant species for rehabilitation of damaged lands. This project will also examine the underlying requirements for comprehensive environmental modeling and simulation products to address environmental issues. The project supports applied research under PE 0602720A, Projects AF25, D048, and A896. Funds in this project are used to support extramural research via university contracts supporting in-house laboratory efforts.

**FY 1999 Accomplishments:**

- 1958 - Explored fundamentals of physical/chemical response of unexploded ordnance on candidate detection sensors. (WES)
- Completed examination of the effects of genetic variety in cryptogamic crusts as a factor in propagation of soil inoculants. (CERL)
- Completed investigation of non-linear hill slope and water channel modeling dynamics for geoarcheology. (CERL)
- Improved theory, scaling, and computational tools for simulating fate and transport of contaminants in groundwater. (WES)
- Explored fundamentals of organic compound fate in freeze-thaw environments and combined biological/geochemical/geophysical measurement and detection. (CRREL)
- Developed kinetic and mechanistic understanding of sonochemical destruction of nitro containing compounds. (CERL)
- Determined plant varieties with improved resilience to military traffic and suitable for revegetation of training lands. (CRREL)
- 1950 - Completed description of major biological degradation pathways of major explosives types; e.g., contaminants and media. (WES)
- Combined low-temperature, bio-geochemical fate of mixed organics and metals with discontinuous permafrost models. (CRREL)
- Established cause/effect relationship of military stressors and ecosystem responses. (WES)

Total            3908

**FY 2000 Planned Program:**

- 4309 - Conduct investigation of photocatalytic destruction mechanisms for nitroaromatic compounds. (CERL)
- Investigate interrelationship between changes in soil microbial composition and plant succession dynamics. (CERL)
- Examine chemical and biological indicators to measure the succession productivity of biological crusts. (CERL)
- Investigate the use of bacterial enzymes for biodegradation of nitroaromatics. (CERL)
- Develop non-linear theories for acoustic behavior for weapons noise mitigation. (CERL)

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>		DATE <b>February 2000</b>	
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>	<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>		
<b>FY 2000 Planned Program: (continued)</b>		<b>PROJECT</b> <b>BT25</b>	
<ul style="list-style-type: none"> <li>- Complete investigation of the fundamentals of magnetic and electromagnetic induction spectroscopy (WES) and pan-spectral electromagnetic sensing (CRREL) to support enhanced discrimination and identification of buried unexploded ordnance.</li> <li>- Complete determination of fundamental mechanisms of soil erodibility and runoff erosivity due to soil freeze/thaw conditions. (CRREL)</li> <li>- Complete determination of genetic characteristics of native plants in cold regions (CRREL)</li> <li>- Complete description of major biological degradation pathways of major explosives types using cold-adapted organisms. (CRREL)</li> <li>- Complete the determination of the phenomenology for predicting the interfacial properties and multiphase soil hydraulic properties of nonaqueous phase liquids (NAPLs) using computational molecular thermodynamics. (CRREL)</li> <li>- Determine the mechanisms of adsorption and transformation mechanisms in low carbon aquifer soils. (WES)</li> <li>- Describe the fundamental mechanisms of biostabilization of polycyclic aromatic hydrocarbons under denitrification conditions in sediment and “reduce-and-bind” phenomena of explosives. (WES)</li> <li>- Investigate ecosystem characterization/monitoring concepts through a basic understanding of microbial respiratory guilds. (WES)</li> <li>- Explore the basic principles of the concentrations (CERL) and immobilization (WES) of explosives contaminants.</li> <li>- Investigate experimental/numerical approaches to describe toxicological interactions of contaminant mixtures (WES).</li> <li>- Investigate dielectric and conductive properties of contaminated fine-grained sediments (CRREL).</li> <li>- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..</li> </ul>	<ul style="list-style-type: none"> <li>• 116</li> <li>Total 4425</li> </ul>		
<b>FY 2001 Planned Program:</b>			
<ul style="list-style-type: none"> <li>• 3432 - Determine effects of soil microbial composition on decomposition, mineralization, nutrient availability, and ultimately succession dynamics. (CERL)</li> <li>- Establish methods to quantify biogeochemical indicators of the health of biological crusts. (CERL)</li> <li>- Complete investigation of bacterial enzymes for biodegradation of nitroaromatics. (CERL)</li> <li>- Validate theoretical noise attenuation rates over sound absorbing surfaces. (CERL)</li> <li>• - Complete description of the fundamental mechanisms of biostabilization of polycyclic aromatic hydrocarbons (PAHs) under denitrification conditions in sediment and of “reduce and bind” phenomena of explosives. (WES)</li> <li>- Determine further mechanisms of adsorption and transformation mechanisms of polycyclic aromatic hydrocarbons in low carbon aquifer soils. (WES)</li> <li>- Investigate other concepts of ecosystem characterization/ monitoring concepts through a basic understanding of microbial respiratory guilds. (WES)</li> <li>- Explore additional basic principles of the concentrations (CERL) and immobilization (WES) of explosives contaminants.</li> <li>- Investigate additional experimental/numerical approaches to describe toxicological interactions of contaminant mixtures (WES).</li> <li>- Determine the dielectric and conductive properties of contaminated fine-grained sediments (CRREL).</li> <li>- Explore the fundamental microbial dynamics in zero-valent iron systems (WES)</li> <li>• 1071 - Develop basic understanding of physical, chemical, and biological phenomena specific to contaminant toxicity assessment and mineralization and to ecosystem maintenance, mitigation, and rehabilitation (CERL, CRREL, WES).</li> <li>Total 4503</li> </ul>			
<div style="display: flex; justify-content: space-between;"> <span>Project BT25</span> <span>Page 47 of 57 Pages</span> <span>Exhibit R-2A (PE 0601102A)</span> </div>			

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<b>ARMY RDT&amp;E BUDGET ITEM JUSTIFICATION (R-2A Exhibit)</b>							DATE <b>February 2000</b>		
<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>A305</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
A305 Automatic Target Recognition	992	1169	1205	1235	1253	1268	1283	Continuing	Continuing

**Mission Description and Justification:** This project focuses on the fundamental underpinnings of aided and automatic target recognition capabilities for land warfare scenarios (primarily characterized by low depression angle, relatively short range and highly intense competing clutter backgrounds). Electro-optic/infrared (EO/IR) imaging systems utilizing advanced algorithms for interpreting and recognizing targets over extended battlefield operating conditions are essential for the warfighter. This project will provide fundamental capability to predict, explain and characterize target and background content. These efforts are aimed at evaluating the complexity and variability of target and clutter signatures and, ultimately, utilize that knowledge to conceptualize and design advanced Automatic Target Recognition (ATR) paradigms to enhance robustness and effectiveness. These ATR strategies include utilization of emerging sensor modalities such as spectral imaging and multi-sensor approaches. These research findings support several technology efforts including multi-domain smart sensors, third generation forward looking infrared (FLIR), advanced multi-function LADAR, and advanced technology demonstrations (ATD) such as Multi-Function Staring Sensor Suite, Target Acquisition, and Joint Combat Identification. Research will also be conducted in the area of acoustic sensors, which can provide very low cost target detection capabilities.

**FY 1999 Accomplishments:**

- 992 - Performed thermal measurements in laboratory conditions on canonical shapes and compared results with model predictions.
- Generated multiple instances of targets using existing capability and compared with measured signatures.
- Evaluated the phenomenology differences of co-registered 3-5 micron thermal images with 8-12 micron counterparts.
- Extended 8-12 micron IR automated detection and clutter rejection algorithms to the 3-5 micron regime.
- Completed initial development of innovative new approaches to acoustic beam-forming and target identification.

Total 992

**FY 2000 Planned Program:**

- 1151 - Assess quality of thermal prediction for various scenarios (e.g., ground vehicles, etc.)
- Isolate high and low false alarm rate images from infrared (IR) data base and compute metrics of image complexity.
- Conduct phenomenological studies of multi-spectral data to determine preferred operating bands for land warfare scenarios.
- Create a matching pursuits detection paradigm to accumulate evidence of primitive sub-elements of target emissions.
- Survey hyperspectral data (both infrared and visible) and its applicability to land warfare missions.
- 18 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..

Total 1169

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>A305</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 1205 - Assess fidelity of thermal predictions for background data; improve model as indicated.</li> <li>- Correlate performance of one or more modern IR ATR algorithms with image complexity measures.</li> <li>- Recommend preferred operating wavelengths for broadband mid and long wave thermal imagers, based on measured phenomenon.</li> <li>- Conduct phenomenological studies of hyperspectral data to assess minimum number of bands to achieve high discrimination performance at an affordable price for land warfare scenarios.</li> </ul> <p>Total 1205</p>		
<p>Project A305</p> <p>Page 49 of 57 Pages</p> <p>Exhibit R-2A (PE 0601102A)</p>		

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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>A31B</b>	
COST <i>(In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
A31B Infrared Optics Research	1985	2337	2426	2500	2531	2561	2589	Continuing	Continuing

**Mission Description and Justification:** This project sustains the Army's theoretical and experimental research in materials for night vision and electro-optic technologies. It generates new technology to obtain unprecedented awareness of the battlefield to continue to "own the night," notwithstanding increased foreign competition. To achieve these objectives, focal plane arrays (FPAs) with significantly improved performance for major platforms, especially future combat vehicles, laser radar (LADAR) techniques that can utilize those FPAs, and low cost night vision aids that allow for wide distribution will be required. Therefore, research is focused on materials, devices and techniques required for high performance smart dual color staring infrared focal plane arrays (IRFPAs), innovative LADAR architectures, and uncooled IRFPAs with moderate performance. For the high performance IRFPAs, mercury cadmium telluride (HgCdTe) detector arrays and quantum well infrared photon detector (QWIPs) are investigated. LADAR research is focused on frequency modulation/continuous wave (FM/cw) techniques that permit high-resolution but low frequency range readout. Research for uncooled IRFPAs is based on thin film ferroelectric materials and novel detector architectures with improved thermal isolation structures.

**FY 1999 Accomplishments:**

- 450 - Designed 0.8  $\mu$ m quantum well modulator for LADAR.
- 1535 - Characterized normal incidence absorption properties for a variety of quantum dot material systems.
- Investigated quantum dot structures for reduced dark current in IR detectors.

Total 1985

**FY 2000 Planned Program:**

- 2324 - Investigate high power 1.5  $\mu$ m diode laser and quantum well modulator/mixer for LADAR with 600 MHz bandwidth.
- Investigate improved thin films and detector structures for low cost uncooled IR detector array.
- Investigate use of vertical cavity surface emitting lasers (VCSELs) for optical readouts of IR FPAs.
- Investigate growth of 8-12 $\mu$ m HgCdTe on silicon.
- 13 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..

Total 2337

**FY 2001 Planned Program:**

- 2426 - Investigate material growth and device design for long wave infrared (LWIR) FPA operating above 100°K.
- Investigate design for IRFPA to be utilized for active and passive imaging.
- Design optical mixer array for LADAR.

Total 2426

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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>B52C</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
B52C Mapping and Remote Sensing	2098	2288	2327	2362	2408	2455	2503	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project supports research in fundamental topographic sciences to improve the tactical commander's knowledge of the battlefield; to extract and attribute natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques, and to explore the potential of space technology to provide real-time terrain intelligence, command and control, and targeting support. The research provides the theoretical underpinnings for Program Element 0602784A, Project A855.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2098 - Evaluated optimal combination of sensor information for generation of topographic data.</li> <li>- Evaluated geostatistical wavelet technique for performing image compression.</li> <li>- Upgraded climate atmosphere model parameters to enhance tactical decision aids.</li> <li>- Investigated methods for automated data capture, characterizing and quantifying models and the dependent relationships across terrain, threat, and military activities.</li> </ul> <p>Total 2098</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2228 - Investigate multivariate statistical analysis, multivariate interpolation, and enhancements for image analysis.</li> <li>- Investigate generating topographic data using a combination of sensor information.</li> <li>- Evaluate initial geostatistical models of climatic atmospheric parameters integrated with line-of-sight models for denied areas where limited or no data is available.</li> <li>- Evaluate models and their performance to characterize expected battlefield state against actual data sets from operational databases.</li> <li>• 60 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..</li> </ul> <p>Total 2288</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2327 - Investigate enhancement of neural net and subpixel methods of feature extraction.</li> <li>- Investigate hyperspectral imagery analysis/segmentation.</li> <li>- Devise model to predict precipitation frequency data in the absence of weather data in denied areas.</li> <li>• - Investigate the potential to integrate empirical and inductive analysis systems.</li> </ul> <p>Total 2327</p>									
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>B53A</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
B53A Battlefield and Environment Signature	3134	3674	3812	3939	3983	4013	4039	Continuing	Continuing
<p><b><u>Mission Description and Justification:</u></b> This project provides an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology, the transport, dispersion, optical characteristics and detection of chemical and biological aerosols, and the propagation of full-spectrum electro-magnetic and acoustic energy. It impacts Army chemical and biological defense operations, electro-optic and acoustic sensors, smoke/obscurant deployments and target acquisition. This project supports Army Strategic Objectives, provides technology for the Integrated Meteorological System (IMETS) and supports Project Reliance under the Defense Technology Area by providing Tri-Service transport and dispersion research. This project is the leader in boundary layer meteorology research over land and urban terrain.</p> <p><b><u>FY 1999 Accomplishments:</u></b></p> <ul style="list-style-type: none"> <li>• 3134 - Analyzed atmospheric effects on acoustic imaging and coherence using a three-axis orthogonal microphone array for enhanced signal processing.</li> <li>- Determined the effects of turbulent intermittency and partial saturation on acoustic target detection and bearing estimation for enhanced signal processing.</li> <li>- Produced methods for approximate representation and decomposition of turbulence structure using wavelet and other analyses, and applied to acoustical scattering calculations for improved acoustic target acquisition.</li> <li>- Completed a set of experiments and theory on the impact of polarization on image propagation in the real and battlefield atmosphere for enhanced electrooptical target acquisition.</li> <li>- Analyzed a coupled high-resolution meteorological transport and dispersion model for an improved hazard avoidance tactical decision aid.</li> <li>- Analyzed a coupled 3-D surface/boundary layer meteorological model that improved the high-resolution meteorological transport and dispersion model by incorporating target area meteorological parameters.</li> <li>- Improved techniques for reducing false alarm rates in real-time detection of biological warfare agents using fluorescence spectra.</li> <li>- Evaluated converting the Battlescale Forecast Model (BFM) to a non-hydrostatic model for improvement of severe weather predictions.</li> <li>- Generated an intermediate scale hydrostatic forecast model to provide BFM with an upgraded capability to depict and forecast mesoscale phenomena not seen in global scale model data.</li> </ul> <p>Total            3134</p> <p><b><u>FY 2000 Planned Program:</u></b></p> <ul style="list-style-type: none"> <li>• 3659 - Model and perform experiments on low-frequency acoustic propagation in forest canopies and littoral regions to assess impact on acoustic sensors.</li> <li>- Complete theory and software linking 3-D atmospheric propagation and radiative transfer models to standard interfaces, such as the Total Atmospheric and Oceans server (TAOS), for DoD simulations to improve virtual testing, analysis, and simulation capabilities.</li> </ul>									
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>B53A</b>
<p><b>FY 2000 Planned Program: (continued)</b></p> <ul style="list-style-type: none"> <li>- Compare coupled 3-D surface layer/boundary layer meteorological model with experimental data for verification and validation of a hazard avoidance tactical decision aid.</li> <li>- Investigate methods for discriminating, in real-time, between naturally occurring and man-made aerosols, using both fluorescence and elastic scattering for real-time detection of biological warfare agents.</li> <li>- Couple canopy and urban flow technologies into transport and dispersion models for more realistic depiction of smoke, clouds, dust aerosols and toxins on the battlefield.</li> <li>- Incorporate detailed Surface Energy Balance in Surface Layer Model for improved thermal dynamics.</li> <li>- Participate in a joint interagency stable boundary layer meteorological field experiment, Cooperative Atmospheric Surface Exchange Study (CASES 99) to achieve a better understanding of stable boundary layer processes for environmental model performance improvements.</li> <li>- Determine new algorithms for depicting physical processes for better analysis and prediction of icing, low level clouds, and precipitation at time and spatial scales required for accurate quantitative depiction of target area atmospheric conditions.</li> <li>- Extend capabilities of acoustic target recognition into more complex environments through research on theory and numerical models of propagation of sound through inhomogeneous anisotropic turbulence including refraction and ground reflections.</li> <li>- Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..</li> </ul> <p>• 15</p> <p>Total 3674</p> <p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 3812 - Investigate and correct problems with transient turbulence model which will decrease computational requirements.</li> <li>- Improve boundary layer model capabilities by incorporating stable atmospheric algorithms.</li> <li>- Model and perform experiments on high-frequency acoustic propagation in forest canopies and littoral regions.</li> <li>- Establish experimental capability for hyperspectral or sensor fusion research with applications for atmospheric propagation to enhance electro-optical target acquisition.</li> <li>- Investigate the use of multiple excitation wavelengths to excite fluorescence for characterizing aerosol particles, especially biological warfare agents, and elastic scattering for characterization of inhomogeneous aerosols.</li> <li>- Evaluate new algorithms for depicting physical processes to better analyze and predict turbulence, wind shear, and visibility at time and spatial scales required for accurate, quantitative depiction of target area atmospheric conditions.</li> <li>- Provide numerical models for acoustic propagation over complex (hilly and mountainous) 3-D terrain to enable acoustic signal analysis.</li> </ul> <p>Total 3812</p>		
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BUDGET ACTIVITY <b>1 - Basic Research</b>				PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>				PROJECT <b>B74A</b>	
COST (In Thousands)	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
B74A Human Engineering	2219	2599	2687	2761	2795	2823	2850	Continuing	Continuing

**Mission Description and Justification:** This project supports research on soldier performance, including the areas of visual, auditory, cognitive, and stress-related performance. The objective is to identify, describe and manage underlying human-system interface factors critical to the design of Army weapon systems. The work in this program is consistent with the Army Science and Technology Master Plan (ASTMP), and the Army Strategic Research Objectives (SROs).

**FY 1999 Accomplishments:**

- 2219 - Completed data collection efforts on human auditory processes in detecting sound in various environments and estimating the distance from the sound source.
- Implemented draft set of operational metrics for measuring depth perception and visual attention.
- Generated a model that evaluates changes in soldier performance and workload as a function of changes in display design.
- Devised random incidence corrector and calibration procedures for a "general damage" auditory model. Submitted impulse noise standards for Committee on Hearing and Bioacoustics (CHABA) review.
- Refined previously completed psychological stress measures and investigated the effects of cognitive skill performance.
- Implemented a methodology for studying the role of visual attention in target acquisition.

Total 2219

**FY 2000 Planned Program:**

- 2574 - Complete analysis and documentation of previous studies on human auditory perception.
- Conduct an experiment to examine target and obstacle detection, depth and distance estimation, and size and depth perception using color night vision devices.
- Generate advanced windows based version of auditory hazard model with active middle ear muscles and azimuthal correction capabilities.
- Conduct a field experiment to measure the effects of information availability (timing and frequency) and information accessibility on situational awareness and decision making ability using helmet mounted displays (HMDs).
- Investigate the effects of specific battlefield stressors on situational awareness and decision making under conditions of uncertainty. Provide a draft set of operational stress measures.
- Provide an analysis of the effects of selective visual attention on target acquisition in static, optically imaged scenes, to AMSAA's soldier-in-the-loop target acquisition modeling effort.
- 25 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..

Total 2599

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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>B74A</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>2687</div> <div> - Investigate the effect of acoustic source motion on human auditory perception.  - Conduct experiments to examine the effects of chromatic and luminance differences between imagery and overlaid graphics and symbology on night vision performance.  - Generate hearing protection algorithms and incorporate into auditory hazard model.  - Measure and compare the individual and combined effects of both audio cues and visual presentation of information on task performance using HMDs.  - Refine and validate previously established operational stress measures.  - Expand studies of selective visual attention on target acquisition to electrooptically (IR and I2) imaged scenes and provide results to AMSAA's soldier-in-the-loop target acquisition modeling effort. </div> </div> </li> </ul> <p>Total      2687</p>		
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<b>BUDGET ACTIVITY</b> <b>1 - Basic Research</b>				<b>PE NUMBER AND TITLE</b> <b>0601102A Defense Research Sciences</b>				<b>PROJECT</b> <b>B74F</b>	
<i>COST (In Thousands)</i>	FY 1999 Actual	FY 2000 Estimate	FY 2001 Estimate	FY 2002 Estimate	FY 2003 Estimate	FY 2004 Estimate	FY 2005 Estimate	Cost to Complete	Total Cost
B74F Personnel Performance and Training	2037	2689	2803	2843	2876	2916	2999	Continuing	Continuing
<p><b><u>Mission Description and Budget Item Justification:</u></b> This project conducts behavioral science research in areas with high payoff opportunities for improved training, leadership, and personnel performance, including: methods for faster learning and improved skill retention; leader effectiveness for improved team and unit performance; understanding the impact of societal trends on Army readiness; and improving the match between soldier skills and their jobs to optimize performance. Research is focused on issues of small-team performance, leadership, and training to ensure that personnel performance and training research keep pace with future mission, structural, technological, equipment, and personnel changes.</p> <p><b>FY 1999 Accomplishments:</b></p> <ul style="list-style-type: none"> <li>• 2037 - Determined the role of transformational leadership behavior on platoon performance.</li> <li>- Generated a model to maximize training effectiveness and efficiency for selected Army tasks, such as topographic map reading.</li> <li>- Conducted research on a technique to better understand the attitudes of inner-city youth toward Army service.</li> <li>- Completed research on the importance of propensity to enlist and actual enlistment behavior for different groups of officers and enlisted personnel.</li> <li>- Completed research on individual differences in spatial ability and how those differences affect an individual's ability to navigate complex routes.</li> </ul> <p>Total 2037</p> <p><b>FY 2000 Planned Program:</b></p> <ul style="list-style-type: none"> <li>• 2623 - Establish preliminary models for effective leadership of small, next-century units to maximize leader and unit resiliency to adversity.</li> <li>- Complete research on analyzing tacit knowledge and how it contributes to effective leadership.</li> <li>- Model the results of a long-term analysis on the durability of tank gunnery skills in the absence of practice.</li> <li>- Complete research to determine the effects of training on the ability of commanders to handle large amounts of information.</li> <li>- Complete analysis of how European Armies have adjusted to rapid changes in their societies.</li> <li>• 66 - Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Programs..</li> </ul> <p>Total 2689</p>									
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BUDGET ACTIVITY <b>1 - Basic Research</b>	PE NUMBER AND TITLE <b>0601102A Defense Research Sciences</b>	PROJECT <b>B74F</b>
<p><b>FY 2001 Planned Program:</b></p> <ul style="list-style-type: none"> <li> <div> <div>2803</div> <div>- Complete a model on the effects of electronic communication on the development of trust between leaders and subordinates.</div> </div> <div> <div></div> <div>- Evaluate the use of latent semantic analysis to assess an individual's knowledge structure and to aid in automatic analysis of free-range text.</div> </div> <div> <div></div> <div>- Determine the effects of different types of missions and gender issues on cohesion, morale, and performance effectiveness.</div> </div> <div> <div></div> <div>- Determine and understand the unique characteristics of digital skills in terms of their effects on learning, durability, and transferability of trained skills.</div> </div> </li></ul> <p>Total      2803</p>		
<div>Project B74F</div> <div align="center"><i>Page 57 of 57 Pages</i></div> <div align="right">Exhibit R-2A (PE 0601102A)</div>		